MAY 4 1911

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second-class matter May 7, 1906 at the Post Office at San Francisco Cal., under the Act of Congress March 3, 1879

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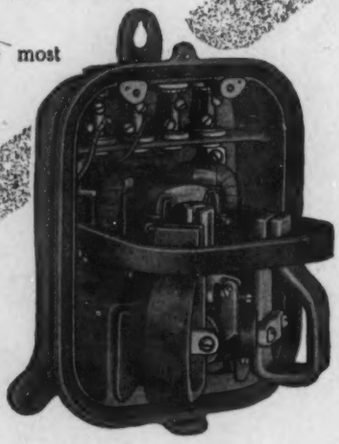

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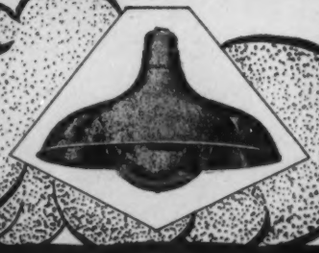

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JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXVI | SAN FRANCISCO, APRIL 29, 1911 | NUMBER 17

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THE BEAR RIVER RESERVOIR

BY WILL T. JONES.[1]

Nestled in the high Sierra Nevada mountains, in the eastern part of Amador County, 6000 feet above the level of the sea, and surrounded by massive walls of superb granite, lies the Bear River reservoir or lake, which is one of the places in which water is stored during the spring of each year, to be used in the operation of the Electra power house during the late summer months and for furnishing water for the mines and for domestic and irrigating purposes in Amador County.

The Standard Electric Company realizing the necessity of ample storage to tide them over the dry season each year, decided upon building a dam across a small meadow through which Bear River runs, and in 1900 active operations were commenced. To build a large storage dam in an isolated section of California, such as this location, a company is confronted with several serious and difficult problems. One of the most difficult is to solve the matter of the transportation of freight. The nearest railroad point to this dam site was Ione, about sixty miles away, and at an elevation of about five hundred feet.

Down-stream Face of the Bear River Dam.

Donkey engines, boilers, burley machines, tons of giant powder, barrels of cement, the large gates and pipes, oakum, nails, blacksmith supplies, boarding house and commissary supplies, in fact everything necessary to equip and maintain a camp where from one hundred to one hundred and fifty men were to be employed, had to be hauled this entire distance. Ten and twelve-mule teams were pressed into service, and a team would make a trip every eight to ten days. There was a continual up-grade from the time Ione was left until within five or six miles of Bear River, when a descent of five hundred feet is made. Still, with this great distance to haul all material over such a rough road, the records show that everything arrived on time and the work was never held up on that account.

At this time the old earth dams, which were practically the only ones constructed previously, were giving away to the more modern stone dams, so the dam at Bear River was built entirely of granite. It might be added that there was not much choice between the earth-fill dam and the stone dam on Bear River, as it is very doubtful whether enough soil could be found along Bear River from its source to where it empties into the Mokelumne River, a distance of about twenty miles, to build an earth dam 30 feet high and 500 feet long. On either side of the river, walls of granite extend up into the air several hundred feet, as will be seen from the accompanying illustrations.

In the construction of the dam two donkey engines were used to place the rocks, while a third donkey loaded the cars in the quarry. Steam was the motive power used to run the burleys, the machines being mounted on tripods. Several holes drilled in the granite walls were filled with ten to forty boxes of giant

[1]Operating and Maintenance Department Pacific Gas & Electric Company.

Five Miles Down-Stream from the Dam

Outlet of Bear River Reservoir.

On Bear River Four Miles Below the Dam

powder, and fired at once by electric exploders operated by batteries. When this charge was let off, thousands of tons of granite were thrown down, the largest pieces blasted again, then loaded on the car and started for the dam. Some of the rocks placed in this dam weigh ten tons each and it was necessary for both engines to place them in the wall.

The dam is 800 feet long on top while at the bottom it is only 200 feet. It is 120 feet wide at the base, 10 feet wide on top, and about 60 feet high. The rocks were laid at a 2-to-1 batter. On the inside of the dam, and set in the rocks at intervals of every ten feet, 12x12 timbers were placed, and to these were nailed double rows of 3x9 native pine, each row being caulked with oakum and so laid that the outside layer of boards overlapped all the joints and cracks in the inside layer. In this manner the leakage was reduced to a minimum. The life of this lining is placed at from twenty to thirty years.

To furnish the lumber necessary for the construction of the dam and for erection of the various buildings for the camp, such as boarding and sleeping houses, barns, etc., the company built a sawmill on Little Bear River, a distance of three or four miles from the dam, and all the lumber had to be hauled this distance. The mill was located in one of the prettiest groves of timber that is in the State of California today. In driving through this grove one is awed by the immense number and the giant size and towering height of these magnificent trees. The writer secured a snap shot of a giant sugar pine which is located in this section. This tree is ten feet in diameter and at least 200 feet high. This grove is composed of sugar pine, yellow pine, fir, spruce and tamarack, so that the matter of securing the necessary timbers for the dam was a simple matter after the sawmill was erected.

The reservoir was completed in the year of 1902, but the winter of 1902-1903 showed the necessity of a larger spillway, so in the fall of 1903 the spillway was enlarged until it is now 80 feet wide and 5 feet deep.

When the reservoir is full it covers an area of about 130 acres, and the water is backed up a distance of 1⅛ miles. During some of the spring storms there is 4½ feet of water running over the spillway, mildly illustrating that where a thousand gallons of water is stored today, a million, yes, ten million, might be stored and used to beautify the fertile valleys of the San Joaquin instead of being allowed to flood them in the winter time.

A tunnel about one hundred feet long, running through solid granite, taps the bottom of the reservoir. The water finds an outlet through three pipes leading through this tunnel, each pipe being fitted with a heavy gate capable of carrying about 1000 inches of water.

The Bear River reservoir is the first to be drawn from each season, and after about ten or fifteen feet of water is drawn out, the gates are closed and the balance of the water is held until the close of the dry season, when it is drawn, provided it is needed. Telephone communication with Electra is kept open the year round with the possible exception of a few days in severe storms, and this is remarkable, considering the fact that some years they have as much as fourteen feet of snow on the flats. In the meantime storage water is drawn from the Blue Lakes, which are located about forty miles further east. In the late fall, especially after a severe storm, the telephone line usually goes down between Bear River and the Lakes, hence the advisability of holding the water in Bear River reservoir until the end of the season. Sometimes a storm in the Fall will develop sufficient water for all purposes, and the storage water being ordered off, after a day or so the water might fail again, and with the telephone to the Lakes out of order, it is a simple matter to have Bear River open up. This water reaches the head of the ditch a great deal sooner than it would from the Lakes.

TRANSMISSION SYSTEMS FROM THE OPERATING STANDPOINT.[1]

BY R. J. C. WOOD.

Requirements.

In order that a transmission system may satisfy the operating engineer it should fulfill the following conditions:

1. The requisite amount of power must be transmitted with reasonable voltage regulation.
2. Interruptions must be reduced to a minimum.
3. Flexibility of operation should be assured.
4. Ease of repair is essential.

Regulation.

The voltage to be used is chiefly, if not entirely, determined by economic conditions. It is as easy to operate with 60,000 volts as 15,000; indeed, there seem to be more short circuits and troubles on the lower voltage lines probably because of the less careful construction used and the lesser absolute insulation margin allowed. We hear from the lines operating above 100,000 volts that they encounter no greater difficulties than do those of lesser potentials.

Up to distances of about 150 miles (241- km.) frequency is not a very vital matter. An increase in voltage will offset the difference in regulation between 25 and 50 or 60 cycles. This factor will be decided by the relative importance of the classes of load demanding either high or low periodicity, so as to make the total cost a minimum, and the consumers' satisfaction a maximum.

There are various formulas for calculating regulation, and it is not necessary to refer to them in detail, beyond remarking that the conditions surrounding the delivery of power are often somewhat indeterminate. The power factor of the load, for instance, is often not to be foreseen between wide limits. This uncertainty renders abortive any extreme accuracy of method as applied to calculating the line.

It will be immaterial, therefore, when considering moderate distances up to 150 miles (241 km.), whether a formula is used, based upon the capacity being all at the center, part at the ends, or uniformly distributed over the line.

The allowable drop of voltage will depend upon conditions. Where power is transmitted in a block from the point of generation to a center of distribution, the regulation may be as high as 25 per cent. In such a case the voltage drop will probably be limited by the value of the lost power rather than by any operating difficulties.

The nature of the load will also bear upon the allowable voltage fluctuations. A mixed light and power load will demand closer regulation than either class of load by itself. If the service is all power a certain unsteadiness of voltage is allowable and if it is all light the changes in load will come on in such a manner that the operator can follow them by hand regulation.

When, however, the transmission line is part of an interconnected network and may have to transmit in either direction, then the regulation must be low in order to keep within the range of the regulating devices used in substations. If, for instance, a hydroelectric and a steam plant are at opposite ends of the line and there are numerous substations between the two, the flow of power may be either way.

Most probably the important center of distribution will be where the steam plant is located, and the voltage must be kept uniform at this end. The voltage at substations along the line will then vary by an amount equal to double the regulation of the line.

This fluctuation can be entirely eliminated from the distributing circuits by using automatic regulators, but the main transmission line should only have one-half the regulation that would be permissible were it a straight one-way transmission.

In loop or ring systems, fed from both ends, the circuit must be heavy enough to permit of feeding the entire load, all around the loop, from either end. If this is not the case it will be found that when certain sections of line have to be cut out for inspection or repairs, the open end of the loop does not get satisfactory service.

The amount of power that should be carried on a single circuit bears a relation to the total power of the system, the importance of certain loads, and the balance that the management draws between insurance against loss of revenue and prestige, and investment costs.

It will probably be wise in systems of 60,000 volts and above to confine the capacity of each circuit to 100 amperes. Baum has shown that the surge voltage, due to sudden interruption, is equal to 200 times the amperes, so that in the above case there would be a rise of 40,000 volts when a circuit breaker went out, supposing it to be open at double normal current. This would give a total voltage of 100,000 when superimposed upon a 60,000-volt line. Line and transformer insulation would stand this momentarily.

In order to deliver uniform voltage to the consumer, a variety of automatic and non-automatic devices are in use. It is questionable whether automatic regulation is desirable at the generating station, unless a type of regulator is used that will discriminate between the drop of voltage, due to increasing load, the drop occasioned by extreme overload, and that due to short circuit.

There are these three conditions to be met. Regulation for variations of load is comparatively simple, but when, due to troubles on the line, certain generating plants get left with more than their share of the load, we need a regulator that will discriminate and lower the voltage to a point where the generators will carry a safe current. Again, if a dead short circuit occurs on the line, the regulator must automatically lower the voltage as much as possible so that the arc may break; it should also, as soon as the line clears up, proceed to slowly build up the voltage to normal. It is too much, perhaps, to ask all this of an inanimate

[1]Paper presented at the Pacific Coast Meeting of the American Institute of Electrical Engineers, Los Angeles, April 25-28, 1911.

device, besides which it might deprive the switchboard operator of his job.

If synchronous apparatus is in use at the receiving end of the line, an automatic regulator controlling its field is quite feasible and should give excellent results. It entails, however, the fixed charges upon a considerable investment and certain operating expenses. Distributing feeders from substations along the line can be automatically regulated by the various types of induction regulators.

Reliability.

Second only to the ability to transmit with reasonable voltage drop is freedom from interruption. To insure continuous operation we must have first class mechanical construction in line and substations. In designing the line we may take the worst climatic conditions on record over at least 30 years and then allow a factor of safety of 2½. This would give a limiting unit tensile stress of 22,000 lb. for copper and steel, and 10,000 lb. for aluminum. Compressive stresses in towers to be reduced by column formulas. The tower should in any case be strong enough to stand the unbalanced stresses produced by the failure of one conductor.

The stress upon pin type insulators may be limited by designing the tie wires to break at the unbalanced stress above mentioned. It is better in case of some catastrophe to a tower, or line, to have the conductors break the ties, than to pull over a succession of towers. To attempt to design a tower that will stand the total breaking stress of all the conductors, leads to economic impossibilities. The transmission should preferably be on a private right of way which should be cleared of trees and brush.

With sufficient spacing of conductors from each other and from the tower structure itself, and with insulators tested to 3½ times the voltage to neutral for grounded Y, and 3½ times line voltage for underground delta systems, there should be no interruptions except those caused by lightning or malicious interference.

The requisite clearance between conductors and tower structure is sometimes underestimated; in certain parts of the country large birds will roost upon the tower. If the insulator is of the pin type they consider it a most excellent device to get under. All goes well until about 4 a. m. in summer time, when the bird wakes up, stretches, and grounds the line. The suspension insulator should be free from this trouble, provided there is enough space between the conductor and the cross arm below it.

To minimize lightning troubles all kinds of arresters have been used as well as ground wires. Ground wires seem to do no harm and in many cases have without doubt prevented trouble. They give an added stiffness to the line mechanically, and are a wise precaution to install in sections habitually subject to storms. So far no arrester is perfect, most or all of them will burn up at times, even the electrolytic type is at times untrustworthy upon delta-connected high-potential systems. The only consolation the operator derives, when his arresters burn up, is the thought that perhaps they saved something more valuable. The most robust type is the horn gap, it needs lots of space to accommodate the power arc that follows a discharge, and it usually shuts the system down when it goes off, but other types sometimes do the same.

It may become necessary to put in, say, electrolytic arresters to take care of the surges, due to switching and minor climatic disturbances, and then protect these arresters with horn gaps, if this be possible, to take the irresistible discharges from heavy lightning, which would cause temporary interruption in any case. When lightning causes a disturbance on the line, the surge will usually not travel far, but will break over an insulator, the arc formed will in many cases break the insulator, due to the intense heat. Ring guards at top and bottom of the insulator have given excellent protection to the insulator, by carrying the arc away from its immediate neighborhood.

The choice of supporting structures will generally lie between steel towers and steel or concrete poles. From some preliminary estimates that have been made it would appear that reinforced concrete poles for long span work will be extremely costly.

Where the districts fed from the line are scattered over considerable territory the transmission will have to be laid out either on a radial or loop system. The loop or ring system has the advantage of giving each substation a source of supply over entirely different routes, which are not both liable to be out of commission at the same time.

If the loop is double circuited throughout, the substations may be divided between the two circuits. Normally, the loop will be open at about its center, being fed from both ends. In case of trouble the circuit breakers at the feeding ends will open up and cut out only about one-fourth of the stations connected. These stations will at once switch over to the good line. The opening in the loop will only be closed under emergency conditions.

The radial system necessitates double circuits on all branches if full protection is to be afforded, and for the same insurance against interruption is more costly than the loop arrangement.

As already incidentally mentioned it will be necessary to have relays and circuit breakers installed upon branch circuits so as to isolate trouble. There does not seem to be any reliable way to automatically cut out the faulty line when one of two circuits, in parallel at both ends, becomes short circuited or grounded. We have had some success when generating at both ends of a two-circuit line. With the inverse time type of relays the faulty line has been cut out automatically at both ends in a great many cases. If generating at one end only then both lines will go out. We need very badly a reliable reverse current relay that will operate at zero voltage.

Any growing system will suffer sooner or later from an inadequacy in its switching devices. Switches that operated perfectly when the total generating capacity was small, will fail more and more frequently to handle the short circuit as the total kilowatt capacity increases.

It will be found that there is no room for the larger switches that should replace the original installation. It is almost impossible to have too much space in the

switch galleries and bus bar compartments, and economy of space here, while it may have been attractive and looked all right when the plant was young, is all the same a false economy. The lack of a few extra feet between switches might lead to an entirely new lay out being required in a few years. It is becoming the practice to install additional reactances in generator circuits to limit the short circuit current of large systems. It seems a pity to have to do this and spoil the regulation of the machines to the point where auxiliary automatic regulating devices are essential. It is a question whether such immense systems should not be normally cut apart into sections of perhaps 50,000 kw. capacity. This would simplify operation and localize trouble.

Even in smaller systems, normally operating as a unit, it is necessary to have points where they can be instantly cut apart, leaving certain loads on certain generating stations. This is the operator's first move when short circuits occur; to separate the several sections so that the greater part of the system may suffer as short a time as possible. If all important transmission lines were built with at least three circuits then they would be self clearing, using only inverse time relays at both ends. It is, however, often difficult to get the money to build three lines where two will apparently suffice.

Too much complication in providing for all imaginable combinations of switching is to be avoided as defeating its own object, which should be to keep the customer supplied with energy as continuously as possible. When the operator has to stop and figure out what to do next in cases of trouble, precious moments are being lost. To insure prompt operation a good telephone line is a necessity and the money will be well spent in building an independent pole line for its use. A telephone line running upon the same towers with the transmission lines is very likely to be inoperative just when it is most needed.

It is perhaps possible to formulate a set of rules, so that each station in a network knows exactly what to do under all conditions, but a word from the load dispatcher is worth many rules in the book.

Repairs.

There should be sufficient circuits and switching facilities so that all sections of the line may be cut out for inspection or repairs. It is an added precaution to have ground clips on all line disconnecting switches, so that when a line is killed with the object of working upon it, it is also grounded at both ends.

Long transmission lines should be sectionalized so that it is never necessary to cut out more than a fraction of the line at any one time. By having switching stations a convenient distance apart they also serve as resting places for the patrolmen. Circuits should also be so arranged upon the towers or poles that men may work upon it without getting into dangerous proximity to the other circuits which will be alive.

Conclusions.

All the foregoing requirements are summed up in which might be as good a motto for the operating engineer as for the system he operates, namely; capability, reliability, flexibility and repairability.

THE REFINING OF IRON AND STEEL IN INDUCTION TYPE FURNACES.[1]

BY C. F. ELWELL.

Electrical Features.

The furnaces for the refining of steel electrically, which have passed the experimental stage, may be divided into two distinct groups, viz., arc furnaces and induction furnaces.

To the former belong the Heroult, Stassano, Keller and Girod furnaces, and to the latter the Kjellin and Rochling-Rodenhauser furnaces. Of the former the Heroult furnace is perhaps the best known and most successful and as comparison always carries more weight than a description, it will be used as the representative of the arc furnaces. The electrical features may be divided up under several heads.

Distribution of Heating Effect of the Current.

Arc Furnaces. In the Heroult furnace the current passes from one electrode through an arc to the slag, through the slag to the upper metal and thence through another arc to another electrode, and of the current which passes through the carbons only a small percentage passes through part of the metal. As the heating effect of the arc is far greater than any effect of the resistance of the charge, there must be large differences of temperature between different parts of the bath of metal even in spite of the great activity of the bath around the electrodes. This is especially the case with a deep bath of metal. It is for this reason that Girod employs a bottom electrode, thinking thus to have these differences of temperature less by passing all the current for the arcs through the bath. From figures given in Stahl and Eisen for a two-ton Girod furnace, it was computed that the resistance of the carbon electrode was 3800 times that of the bath of metal and so 3800 times more electrical energy was converted into heat in the carbon electrode than in the bath itself. From this it is seen that if the current in the bath of metal produces any considerable part of the heat of the furnace, there must be a large loss of energy in the carbon electrode. The only correction for this is to make the electrodes larger, and the working limit has already been reached. The fact is that the bath is very little heated by the passage of the current and almost all the heating in this type of furnace is done by the very localized heating of the arc. The matter of the losses of energy in the carbons will be taken up under the heading of efficiency.

Induction Furnaces. The principle of the induction furnace is already well known to you but in order to compare the Kjellin and Rochling-Rodenhauser types it will be well to repeat briefly the principle of operation and the type of construction of the Kjellin type. The furnace consists essentially of an iron core around one leg of which is wound a primary winding enclosed in a refractory case and usually cooled by means of forced draught. The annular hearth surrounds this primary coil and is separated from it by means of refractory material. This hearth contains the metal and acts as a secondary winding of one turn. The voltage induced in this turn is quite small so that

[1]Paper presented at the Pacific Coast Meeting of the American Institute of Electrical Engineers, Los Angeles, April 25-28, 1911.

the energy transformed from the primary coil results in a very large current in the secondary, which heats the metal and thus nearly all the electrical energy is converted into heat in the metal to be melted. The ring being of constant cross section, the heating is about uniform over the whole bath of metal. The Rochling-Rodenhauser furnace has a differently shaped hearth to the Kjellin furnace and a description would not be out of place at this juncture. The furnaces are constructed either for single or three-phase current. In the former case there are two grooves and in the latter, three grooves. In both cases these grooves, which are similar to the grooves in the Kjellin furnace, open into a distinct open hearth. The cross section of the grooves is comparatively small and they form the secondary circuits in which the currents which heat the metal are induced. Lateral doors are provided so that the contents of the working chamber may be watched, slag drawn off or charge put in. The chief electrical difference between the Rochling-Rodenhauser and Kjellin furnace is that a distinct secondary winding is provided in the former and the current induced is led by means of heavy terminals to plates embedded in the refractory material of the furnace. This refractory material becomes an electrical conductor at the higher temperatures, and this enables an additional circuit to be formed, so that the currents induced in the secondary winding pass through the bath of metal, heating the bath still further. The current also serves to neutralize the great self-induction of the secondary and a better power factor is obtained. The point to be recognized here is that the heating is uniform and not localized as in the Heroult furnace.

Variation of Load on Supply Mains.

Arc Furnace. The instability of an arc is well known and the load on a supply circuit, even with constant watching, varies very greatly. If the furnace has its own generator the regulation can be effected more simply, but the best furnace is one which can be connected to regular three-phase supply mains. To do so with the Heroult furnace means motor-driven electrode regulators, etc., and even then the furnace is not a very desirable load.

Induction Furnaces. The changes in load on an induction furnace are always of the intentional kind and sudden changes of load are practically impossible with an induction furnace.

Adaptability to Connection to Supply Mains.

In the question of power factor the Heroult furnace shows some advantage over the Kjellin furnace for in order to build a Kjellin furnace of eight-ton capacity and keep the power factor up to 0.6 or 0.7 it was necessary to lower the frequency to five periods per second. As a five-cycle generator costs more than twice as much as a 25-cycle generator this is a serious question. But with the Rochling-Rodenhauser furnace the current in the second secondary winding can be used to neutralize the effect of self induction to such an extent that a seven-ton furnace may be operated with 25 cycles with a power factor of 0.6 while a three-ton furnace on 25 cycles has a power factor of 0.8. The smaller Rochling-Rodenhauser furnaces are operated from 50 cycles with power factors of 0.85 and 0.8. In my opinion the most economical way to correct this evil is by using fixed condensers which cost only a small percentage of the cost of the furnace and the power factor may be made as high as desired.

Electrical Efficiency.

Arc Furnaces. The before mentioned Girod furnace with but one electrode of 14 in. (35.5 cm.) diameter and a current of 6200 amperes at 60 volts showed a power loss of 10 per cent in the electrode alone. In the Heroult furnace the current is in general smaller but there are two electrodes in series and the result is about the same. Not only is energy lost in the electrodes by reason of their high resistance but a large amount is also lost by means of the water cooling of the jackets which is necessary because of their high conductivity for heat. The cost of maintenance of carbon electrodes is also considerable. Radiation loss is greater with the arc furnaces because a great deal of the heat of the arc is reflected to the roof which must be water cooled to last, and even then has to be renewed about every 14 days.

Induction Furnaces. Tests made on a 3.5 ton furnace at Volklingen have shown an electrical efficiency of 97 per cent which is a contrast to the 10 per cent lost in electrodes alone in arc furnaces. The electrode plates never wear out for they do not come in contact with the molten metal or slag and the portion of the lining which acts as a conductor has been found in practice to last longer than any other portion of the lining.

Summary of Electrical Features.

a. Heating of metal bath is much more uniform in induction furnace.

b. The variation of load is much less with the induction furnace.

c. The adaptability to connection to existing power networks is in favor of the induction furnace.

d. The efficiency is in favor of the induction furnace.

Metallurgical Features.

The earlier induction furnaces, i.e., those of the Kjellin type did not show many metallurgical advantages except that it was possible to treat much larger charges than with crucible methods. They were quite unsuited to working with slag because of the shape of the hearth and so only served to melt pure materials. The shape of the Rochling-Rodenhauser furnace is such that slags can readily be handled and refining carried on. At the same time it can be used for smelting work whenever necessary, and as much larger charges can be worked, a considerable saving is made in crucible steel working.

The advantages of the electric furnace are:

1. On account of the convenient regulation of the temperature attainable the phosphorus can be removed until only a trace remains.

2. It is especially suitable for the most thorough desulphurization.

3. When the refining is complete, the charge can be left in the furnace as long as may be desired without change of composition.

At Trollhattan, Sweden, the furnace is started by means of a ring of metal. The cold materials are charged gradually until all are melted. Continuous

operation is possible by leaving a portion of the molten metal in the furnace after each teeming.

At Volklingen, Germany, the furnaces are supplied with molten metal from basic Bessemer converters which contains about 0.08 per cent S and 0.08 per cent P. The extent of the dephosphorization and desulphurization depends on what the steel is wanted for.

The oxidizing slag is formed from lime and mill-scale or ore, which is removed as far as possible when dephosphorization is complete. The recarbonization takes place and a slag free from iron is formed for desulphurization. A typical slag for desulphurization has a well-known white appearance and falls to a white powder on exposure to the air. When the slag has this property, the charge may be left as long as desired in the furnace. The furnaces are entirely emptied after each charge as the molten converter steel allows the load to be readily brought to a satisfactory figure.

When not working, about one-third of the normal energy will keep the furnace hot. The seven-ton furnace at Volklingen has been 30 hours without taking any current and was heated up again with normal energy consumption. Within half an hour the metal began to glow and regained its normal temperature after four hours and the charge was finished up in the regular way. At the works at Volklingen no work is done on Sunday but there is no difficulty in starting up the furnaces with unfinished charges from the previous Saturday.

The natural circulation which takes place in induction furnaces serves to thoroughly mix the charge and the management of the Poldihutte, Austria, made a test in which seven samples were taken from six different places in the furnace and the analysis of these samples is shown in the following table:

	Carbon Per ct.	Manganese Per ct.	Silicon Per ct.	Phosphorus Per ct.	Sulphur Per ct.	Chromium Per ct.
1	0.81	0.27	0.335	0.031	0.007	1.00 1.01
2	0.77	0.25	0.340	0.030	0.008	1.00 1.01
3	0.85	0.28	0.345	0.029	0.007	1.00 1.01
4	0.82	0.27	0.335	0.039	0.009	0.98 0.99
5	0.78	0.25	0.335	0.030	0.009	0.99 0.96
6	0.78	0.27	0.419	0.031	0.010	0.99
7	0.79	0.28	0.326	0.030	0.009	0.98

The furnace was teemed 37 minutes later and a sample cast out of the ladle gave the following analysis:

Carbon	0.77 per cent.
Manganese	0.29 "
Silicon	0.396 "
Phosphorus	0.031 "
Sulphur	0.009 "
Chromium	0.99 "

That the Rochling-Rodenhauser furnace is no longer an experiment is shown by the fact that the 3.5 ton furnace was worked for a whole year producing steel for rails, and more than 5000 tons have been sold. The eight-ton furnace has been running since November, 1908, an average of 14 days to a lining and 1200 tons of rails to a lining. The management contemplates the building of a 16-ton furnace as the next step.

At Dommeldingen the two-ton furnace is used to refine crude pig iron.

	Analysis of charge.	Analysis of cast.
Carbon	4.0 per cent	0.5 per cent
Phosphorus	1.8 "	0.025 "
Sulphur	0.2 "	0.03 "
Manganese	0.0 "	0.76 "
Silicon	1.05 "	0.056 "

Breaking strain	95,000 lb. per sq. in.
Elongation	20 per cent
Contraction of area	36.53 "
Duration of conversion	5 hours

Summary of Metallurgical Features.

1. Having no electrodes, facilities are provided for heating the bath without introducing impurities and the charge may be left indefinitely in the Rochling-Rodenhauser furnace without change.

2. Having a large open hearth, (in the 1.5-ton furnace it is 60 by 26 in. or 1.52 by 0.65 m.) with doors it is possible to do any class of refining in the Rochling-Rodenhauser furnace much the same as in the open hearth furnace.

3. When the hearth doors are closed the Rochling-Rodenhauser furnace is air-tight and may be left for long periods without great loss of heat, making intermittent working possible.

4. The natural gentle movement of the charge allows of complete mixing of the ingredients of the charge, and is not sufficient to attack the lining.

Costs.

Royalty. The German users of the induction furnace pay $0.65 per ton for rail steel and $1.50 per ton for crucible quality steel. This is for small daily production. For 1000 tons daily the royalty is placed at $0.36 per ton for rail steel and for 1200 tons daily it is $0.50 for crucible quality steel.

Energy Required. A great many figures have been given out most of which were for small furnaces and special runs. The plants at Trollhattan and Volklingen being in commercial operation supply the most reliable figures obtainable.

Cold Pig and Scrap. With cold materials, refining, etc., to crucible quality steel is done with 600 to 900 kw.-hr. per ton according to the size of the furnace.

Hot Pig and Scrap. With hot pig iron and cold scrap crucible quality steel is obtained with 300 to 700 kw.-hr. per ton according to the proportions of the two ingredients and the size of the furnace.

Hot Metal from the Converter. Converter material with an analysis of P, 0.08 per cent; S, 0.08 per cent; Mn, 0.5 per cent; C, 0.1 per cent is refined to steel for rails with an analysis of P, 0.05 per cent; S, 0.04 per cent; Mn, 0.85 per cent; C, 0.5 per cent with 100 kw.-hr. per ton in a seven ton furnace. Same material is refined to high quality steel showing only traces of P and S; Mn, 0.2 per cent; C 0.5 per cent with 250 kw.-hr. per ton.

Hot Metal from Open Hearth Furnace. Material from open hearth furnace, already dephosphorized and desulphurized and containing 1.22 per cent C; Mn, 0.38 per cent; Si, 0.21 per cent to high quality steel with 200 to 250 kw.-hr. per ton.

Cost of Production. (1) For a 1.5-ton furnace melting scrap and refining to pour best steel for steel castings. Furnace of the three-phase, tilting type. 50 cycles, 210 kw. and power factor 0.80.

Interest Charges. Cost with all accessories about $9000. With 10 per cent for interest charges gives $900 annually. Using 290 working days in a year and six charges, 3 to 3.5 hours each, daily and 1500 lb. to a charge gives 4.2 tons daily and 1220 tons yearly, This is equivalent to about 21 hours working. Cost per ton for interest, $0.74.

Labor. Two men can attend to this furnace with ease, as the electrical part requires no special attention. The melter adjusts the temperature and watches the metallurgical process. The helper sees to the fan and charging, etc. Allowing two shifts and $5.50 per shift or $11 daily gives a labor cost of $2.62 per ton of steel.

Lining. Relining may be done every 8 or 14 days. It takes three tons of magnesite and 0.36 ton of tar to completely reline the furnace. The relining is done with half new material and half old. For getting out the old lining, mixing material and putting in the new, four men are allowed 16 hours. Cost of lining per ton of steel, on an average, $1.50.

If lined with dolomite, which is cheaper, and every 14 days then lining cost allowing one-third material recovered is 31.00 per ton of steel.

Keeping Warm. When the furnace is not used for several hours during the night, it must be kept warm, for which about a third of the working amount of energy is necessary. In this way if normal energy is 200 kw. then about 200 kw.-hr. will be necessary to keep the furnace warm over the three-hour period of rest. For six working days this is necessary five times and 1000 kw.-hr. must be charged up to heating.

Cost of keeping furnace warm at $20.00 per kw.-yr. is $0.09 per ton of steel.

Cooling of Transformer. The blower takes a 2.5-h.p. motor or 1.8 kw. and for 24 hours = 43 kw.-hr.

Cost of cooling transformer per ton of steel, $0.02.

Energy Consumption. From cold materials about 850 to 900 kw.-hr. are necessary, in this size furnace. Taking larger figure the cost of energy per ton is $2.06.

Royalty. In the United States, on the basis of a plant of 50 tons daily the royalty would be about 50 cents per ton.

SUMMARY OF COST.

Interest charges	$0.74
Labor	2.62
Lining	1.50
Keeping furnace warm and cooling	0.11
Royalty (approx.)	0.50
Energy for melting and refining	2.06
Total	$7.53

The figure $7.53 is the working cost which must be added to the cost of the materials in order to find the cost of crucible quality steel from scrap. The above figure would be more reasonable with larger furnaces.

Cost of Production. (2) For a two-ton, 300 kw., three-phase tilting furnace.—Molten converter steel to quality steel for castings.

Cost with all accessories about $12,500. With 10 per cent for interest charges gives $1250 per annum. Allowing 250 working days in the year and 16 tons per day gives 4000 tons per annum or $0.31 per ton of steel.

Interest charges per ton of steel	$0.31
Power for heating up, per ton of steel	0.02
Power for refining, allowing upper figure of 300 kw.-hr. at $20 per kw.-yr	0.68
Air cooling of furnace core	0.01
Cost of lining every ten days. (German figure)	0.35
Wages allowing $16 per day	1.00
Royalty on basis of 50 tons daily	0.50
Total cost per ton of steel	$2.87

This figure would give a good idea of the cost of converting molten pig iron into steel, exclusive of the ferro alloys.

Cost of Production. (3) For a five-ton, 550 kw., three-phase tilting furnace.—Molten converter steel to crucible quality steel.

Cost with all accessories about $22,000. With 10 per cent for interest charges gives $2200 per annum. Reckoning 250 working days in the year, each one with eight heats of five tons, the yearly production would be 10,000 tons, or $0.22 per ton for interest charges.

Interest charges	$0.22
Power including heating up. For a monthly average of 230 to 280 kw.-hr. per ton and taking the higher figure	0.64
Cost of lining. (German figure)	0.30
Wages allowing $20 per day	0.50
Air cooling of core	0.01
Royalty (Approx.) Basis of 50 tons daily	0.50
Total	$2.17

Cost of Production. (4) For a seven-ton, 750 kw., three-phase, 25-cycle, 0.6-power factor tilting type furnace.—Converting molten converter steel into high grade rails.

Cost with all accessories $27,000. Interest charges at 10 per cent gives $2700 per annum. Allowing 100 tons daily (the makers claim a production of 140 tons) and 250 working days in the year gives a yearly production of 25,000 tons of rail steel and interest charges per ton of steel = $0.11.

Interest charges	$0.11
Power for heating up	0.01
Power for refining. Makers claim 100 kw.-hr. per ton. Allowing 150 kw.-hr. per ton	0.34
Power for cooling	0.01
Cost of lining. Pneumatically tamped. Two foremen and six laborers, or $21.00 daily. Per ton	0.02
Cost of lining material. (German figure)	0.06
Wages. Two head melters at $3.00 and 10 helpers at $2.50, $31.00 per ton	0.31
Royalty on rail steel, one furnace in U. S.	0.35
Total	$1.21

This is the conversion cost which added to the value of the pig and ferro alloys, etc., gives the cost of steel for rails. The Prussian Railways paid $10 extra per ton for rails made in this furnace and were well pleased with the product.

Cost of Production. (5) For a seven-ton, 750-kw., three-phase, 25-cycle, 0.6-power factor, tilting type furnace.—Molten converter steel to highest quality steel.

This furnace will produce about half the steel of this quality as when working on rail steel or 50 tons daily.

The cost per ton under these conditions is about $2.00 per ton including royalty.

SUMMARY OF COSTS OF PRODUCTION EXCLUSIVE OF MATERIALS.

1.5-ton furnace melting scrap and refining to pour high grade steel for castings. Per ton	$7.53
2-ton furnace refining molten converter steel to high grade steel. Per ton	2.87
5-ton furnace refining molten converter steel to high grade steel. Per ton	2.17
7-ton furnace refining molten converter steel to high grade steel. Per ton	2.00
7-ton furnace refining molten converter steel to high grade rails. Per ton	1.21

ELECTRICAL PRECIPITATION OF SMELTER FUME.[1]

BY E. G. COTTRELL.

The attempt to utilize electric current for the precipitation of suspended matter, particularly with regard to smoke and fumes, dates back a great deal further than we perhaps realize. The first suggestion of its use that I have been able to find was in 1824, when Hohlfeld, in Kastner's Archiv. Naturl, suggested that by the use of static electricity smoke might be precipitated. It seems then to have dropped out of sight for a quarter of a century, and to have been re-discovered and re-proposed by Guitard in 1850, in the Mechanics' Magazine. Here again it was simply thrown forward as a suggestion; it came to no practical application, and lay dormant again until discovered independently for a third time by Sir Oliver Lodge in 1884.

Lodge came on it rather indirectly. He was working on the effect of depositing solids on cold bodies. If you take a cold rod of metal, and place it in a mass of smoke, and then look along the rod, you can see a thin clear space free from the smoke, surrounding the rod. The explanation that Lodge offered, and which has been substantiated by others, is that we have a molecular bombardment of particles; that is, the cold rod, reducing the velocity of the gas molecules around it, gives a chance to the more heated spaces outside to allow their molecules to bombard these particles at a higher rate than the cold gas molecules in contact with the rod. In studying this phenomenon and the general sedimentation of dust, he was led to try the effect of the electrification of the rods as an incident of the work, and was surprised to find that the smoke and various fumes cleared up. He followed it out in rather more extensive detail, and presented his results in a lecture before the Manchester Section of the Society of Chemical Industry, which was later published in the journal of the society.

This seems to have been the first incentive to a general study of the problem. It did not take long for the practical men to see the possibilities in the work, and in the next few years it was taken up actively, and the first patent was drawn on the precipitation of smoke by electrical means. This initial patent, which claimed the application of electrical charges to the precipitation of suspended matter in general, was taken by Alfred Walker, of the firm of Parker & Walker, lead smelters, in Lancashire, and was carried out not only on paper, as many patents are, but was embodied in an actual installation. The Wimshurst machine had just come out at that time, and great things were expected of it. It is rather amusing today with our present knowledge to read the predictions made at the time that the Wimshurst, being so perfectly adapted to commercial operation, was undoubtedly the solution of the problem. Two large machines, with plates about five feet in diameter, were constructed for this purpose. The installation evidently did not prove a success as no further account of it is to be found.

There are two problems which stand out quite distinctly, one, the treatment of commercial gases, passing through flues, in which they must be handled promptly before discharge into the atmosphere; and the other to which Professor Lodge has more particularly given his attention—the treatment of fog and smoke in the open, particularly fog, where you have a tremendously extended mass but relatively quiescent. You notice that fogs are usually in quiet air, and the idea of simply agglomerating the suspended particles into larger masses and then allowing them to settle is more readily applicable to fog treatment than it is to the treatment of industrial flue gases. The work that I will show you this evening has been almost entirely confined to the second problem, that is, the treatment of industrial gases, so what I have to say must be taken in that sense, and not as relating so particularly to the treatment of fog in the open. In the latter case some very interesting work seems to have been done in Europe upon the effect of powerful electromagnetic waves in causing agglomeration in foggy air, but very little seems to have been published as yet, probably on account of its commercial possibilities. It depends more particularly upon sending the train of Hertzian waves out into the air, and in that way producing an agglomeration of the fog particles which then fall as rain. This seems rather a promising direction for that line of work.

That same treatment does not apply practically, as far as we have been able to determine, to the treatment of industrial gases, because of the high velocity here encountered. You usually have to treat a very large volume of gas in a relatively small space, both of time and in the sense of area. The capacity of the flues is naturally limited, and you cannot afford to hold the gases long, and you must treat them rapidly as they move.

(The speaker then exhibited a number of stereopticon views, showing various installations erected under his direction for the treatment of rapidly moving gases in large flues of smelters and similar establishments, and showing the effect of the apparatus used, after which the process was demonstrated by experiments).

[1]Stenographic report of talk before San Francisco Section A. I. E. E., March 24, 1911.

The synthetic ammonia process has passed from the discoverers to the Badische Anilin and Soda-Fabrik, of Germany, which informs the Berlin consulate general that the process is only in the experimental stage and that there is no immediate prospect of synthetic ammonia being placed upon the market. According to a local technical journal, the chemical inertia of nitrogen toward hydrogen, which has heretofore been an insurmountable obstacle to the synthetic production of ammonia, was overcome in the case of the Haber process by high pressure applied in the presence of catalytics. A mixture of the cheapest nitrogen and hydrogen gases in the proportion of 1 to 3, with uranium powder containing carbon added as a catalytic, was converted into ammonia gas (NH_3) under a pressure of 200 atmospheres and at a temperature of 500 degrees C. Only about 8 per cent of the gas mixture was converted, but by removing the ammonia gas, either by liquefaction or by means of a chemical absorbent, the transforming process may be made continuous.

IMPROVEMENTS IN EFFICIENCY OF ELECTRIC LIGHTING PROPERTIES AND WHAT THE PUBLIC GAINS THEREBY.[1]

Gain to the public through improvements in the efficiency of electric lighting properties was discussed and demonstrated by W. H. Blood, Jr., Tech. '84-'88, of the Stone & Webster Engineering Corporation, Boston. At the present time, said Mr. Blood, when so much is being said about "efficiency" and "scientific management," and when the public service corporation is accused of being "greedy" and "unscrupulous," it may be well to spend a few moments in considering what the application of science to the electric lighting industry has accomplished and to what extent the public has been benefitted thereby.

In 1888, two of us, for our thesis work, tested the largest dynamo that the Institute of Technology possessed, and found the highest ratio of electrical output to mechanical input to be about 70 per cent. Today, machines of this size operate at about 85 per cent, while larger units give efficiencies of 95 or even as high as 97 per cent. Assuming that this improvement in efficiency amounts to 25 per cent, on the average (which is a low estimate), it would mean that we are today saving 25 per cent of the fuel which we should have burned had there been no improvement in electrical efficiency since the year 1888.

Applying this figure to the industry as a whole and basing our estimate upon figures given in the Census Reports on the cost of fuel used by the electric light and electric railway plants in the United States we prove, without fear of contradiction, that our electrical engineers have brought about the conservation, for future generations, of some $12,000,000 worth of coal per year, and this solely on account of a single item—improvement in the efficiency of electric generating machines.

We find, on looking up the back records, that in the early days it took, as a rule, ten or more pounds of coal to produce one kilowatt hour. In many modern stations it requires only three pounds of coal per kilowatt hour, and in some cases even, less than this. This means that only 30 per cent as much coal as was demanded twenty years ago is now needed to produce a unit of electricity.

What effect does this have on the cost of electricity? Take for a concrete example an electric light plant of 5,000 kw. capacity. Its first cost, including distributing lines, would be approximately $1,250,000, and under ordinary conditions it would have an earning power of about $312,000. The operating expenses, including taxes and depreciation, would be, say 65 per cent, of this, or $202,800, which would leave for interest on investment and reserves $109,200.

Now suppose that instead of having a power station which runs on three pounds of coal per kilowatt hour, it was like those in operation in 1888, and consumed ten pounds of coal per kilowatt hour. With the same output over 300 per cent more coal would be required; or, instead of producing a return of 8¾ per cent on the investment (which we assume is the same in both cases) there would be a deficit of about 5 per cent, or, if you please, stating the results in another way, while the company has been making systematic reductions in the rates from 15 cents per kilowatt hour down to 10 cents per kilowatt hour, its stockholders here had to be content with a constant and low rate of return upon their investments. If you will study the records of the electric lighting companies given in the reports of the Massachusetts Gas and Electric Light Commissioners, you will find that this is exactly what has taken place in this State at least.

But we have not told the whole story yet. The development of alternating current apparatus has enabled the electric lighting companies to distribute their product from the power station to the consumers at a much less cost and has made it possible to transmit it for distances which were not dreamed of in the early days.

High voltage transmission has further enabled us to utilize that were heretofore useless and almost inaccessible waterfalls. Without this development, Los Angeles would be forced to burn thousands of barrels of oil each day instead of using the mountain streams two hundred miles away for making her streets at night almost as brilliant as in the day. But for this development Seattle would not be able to utilize the melting snow and ice from the glaciers of Mt. Rainier to operate all her street cars and other public utilities. Without high tension alternating current apparatus, Niagara power could not be transmitted and used in the Lake cities of Canada, or in Buffalo, Syracuse or Rochester. The utilization of Niagara power alone means a yearly saving of at least 2,500,000 tons of coal, or the conservation of $6,000,000 to $7,000,000 of fuel annually. The development of the high tension alternating current system has therefore not only been the means of reducing the cost of distributing electric power and of preventing the congestion of manufactories, but has also been a great factor in conserving our natural resources.

Turn now to the apparatus by which the consumer transforms the electricity delivered to him into light, heat and power. Here again scientific study and research have done much to increase the efficiency of the apparatus used. The reduced price of electricity by itself, therefore, does not indicate the total saving of the consumer. We have today our lamps of more than 100 per cent greater efficiency than those of a few years ago.

The wonderful advance which has taken place in the last twenty years in the electric lighting industry has been due to the combined efforts of the operating engineer and the designing engineer. It has been a gradual and steady evolution and is still going on. The industry itself has not reaped all the benefits, for while the returns on electric light investments have been sure they have not been as large as the dividends which the public has received in the reduced cost of electric light and power.

[1] From a paper presented before the Congress of Technology at the Fifteenth Anniversary of the Granting of the Charter of the Massachusetts Institute of Technology.

CHINESE TELEPHONE AND TELEGRAPH SYSTEMS.

On January 1, 1909, there were in Tientsin 1304 telephone connections, of which 53 were extension or private lines, 4046 miles of cable wire, and 1853 miles of open wire. After that date the telephone administration adopted the Chinese calendar, and the following official returns are furnished: End of 12th moon, 1st year of Hsuan Tung (February 13, 1910), 1518 subscribers, of which 70 were extension or private lines, 4468 miles of cable wire, and 2016 miles of open wire. End of 10th moon, 2d year of Hsuan Tung (December 1, 1910), 1777 subscribers, of which 127 were extension or private lines. The wire mileage is not made up until the end of the Chinese year.

The engineer in charge of the Peking Telephone Administration furnishes the following figures:

Year.	Subscribers connected to office.	Subscribers waiting for connection.	Mileage of wires.
1908	1,563	784	5,198
1909	1,608	970	5,353
1910	1,623	1,251	12,819

The engineer further says: "From 1907 we stopped connecting subscribers, as our switchboard capacity was not sufficient, unless we should entirely change the switching system. In the summer of 1910 we commenced extension of the telephone work, installing common battery multiple switchboards and laying underground cables. This work is still going on."

The new telephone installation, now in progress in Peking, will cover both the Tartar and the Chinese city. The work is being done directly by the Imperial Chinese Telephone Administration, with the assistance of two specialists sent out for this work by the Western Electric Co., of New York and London, which furnishes the machinery and apparatus. It is expected that the installation will be completed and ready for use by May, 1911. The system is known as the common battery (magneto) system, which has been in operation in the United States for more than 12 years.

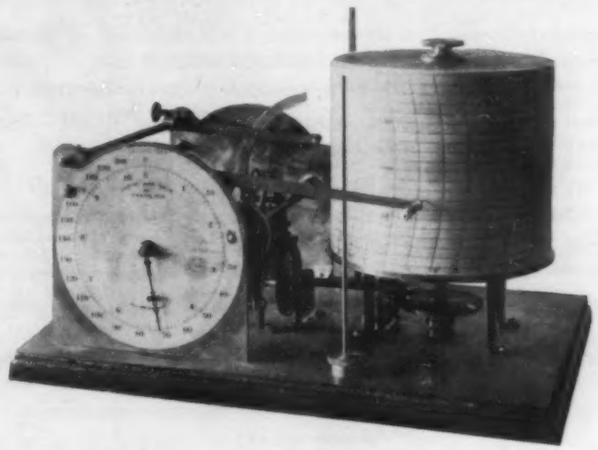
Two telephone exchange buildings have been erected. The first is a large foreign edifice, of red brick, on the Hatamen Road, and the second is in the Chinese city, close to the Tartar city wall. Three thousand telephones are being put up, but the plant will admit of an increase to 12,000, as the switchboards at each of the two exchanges have a capacity of 6000 telephones. The telephone wires have been laid underground. This, although it has increased the initial outlay, will greatly reduce the subsequent cost of maintenance, as no damages to poles or wires, caused by gales, etc., will have to be reckoned with.

The cables are of lead tubing 3½ in. in diameter, and contain 400 wires. The wires are wrapped loosely in paper, the function of the paper being merely to hold the wires apart. The cables are laid in earthenware pipes.

All the foreign subscribers' numbers will be assembled on one section of the switchboard, which will be in charge of operators who understand English. This will save a great deal of time and worry.

NEW INDICATING AND RECORDING WEIR GAUGE.

A valuable device, recently designed and constructed by R. G. Manifold and C. O. Poole of Los Angeles, Cal., is illustrated herewith. This apparatus is constructed with a float operating a vertical rack meshing into a gear of proper diameter, and operating a cross shaft carrying a spiral cam, from which the motion of the recording pencil is derived; this cam, which is almost a logarithmetic spiral, is designed to give a motion to the pencil proportional to the flow in second feet of water over the weir, and not simply



the height as in other gauges; the recording drum is revolved by a special double spring clock, of strong design, and can be geared to register daily or weekly readings; in addition to the recording drum apparatus there is a fixed dial, on which is read the height of the water and the corresponding flow at any time.

After putting a new card on the drum the thumb nut on top is loosened and hour line set exactly, there is also a tangent screw for raising or depressing the pencil to correspond with indicated flow.

The principal advantage of this style of gauge is, that the card taken from the machine may be computed by getting the area with a planimeter and applying a suitable constant.

A condensing gas stove recently perfected in England provides that the fumes from the burnt gas rise into a flat, oblong tank, about 3 feet long, which forms the top of the stove. Thence they are conducted by four tubes, also about 3 feet long, down to a similar tank, which constitutes the base. This tank contains water and slaked lime, and the fumes, cooled by their circulation through the apparatus and by contact with the water, pass round to meet the hot fumes in the flue behind the burners. The result is rapid condensation, with production of a vacuum, which causes the draft necessary to draw air into the fire. The water of condensation absorbs the carbonic acid, and, trickling down into the bottom tank, combines with the lime, forming carbonate of lime, which, being insoluble, is precipitated. As the slaked lime is used up, the carbonic acid combines with the carbonate of lime to form bicarbonate, which is soluble, and the solution, when its amount becomes excessive through the constant additions of condensed water, is drawn off by a small tap

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE
Technical Publishing Company
E. B. STRONG, President
A. H. HALLORAN, Vice President and Managing Editor
C. L. CORY, Secretary.
DIRECTORS
R. J. DAVIS A. M. HUNT A. H. HALLORAN C. L. CORY E. B. STRONG
604 MISSION STREET, SAN FRANCISCO

EASTERN OFFICE, 140 NASSAU STREET, NEW YORK

TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	5.00
Single Copies, Current Month	each	.25
Single Copies, prior to Current Month	"	.50

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal." July 1895.
Entry changed to "The Journal of Electricity." September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas." August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas." Weekly.

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Pacific Coast Electrical Convention

The past week has witnessed two national conventions of electrical men on the Pacific Coast. A representative body of the business interests assembled at the Del Monte meeting of the National Electrical Jobbers' Association, while the technical men met at the Los Angeles session of the American Institute of Electrical Engineers. Aside from the value of the papers presented, both conventions were distinguished by a lavish entertainment characteristic of Western hospitality.

Their success should be an added incentive to like meetings of other national organizations in the future, especially that of the National Electric Light Association for which Portland is the claimant. It is no more than logical, also, that Seattle be the scene of the next Pacific Coast meeting of the American Institute of Electrical Engineers, which custom was inaugurated last year at San Francisco.

Lessons for the Designer

A remarkable similarity in operating methods of widely-separated power plants is exhibited in R. J. C. Wood's abstract treatise, as published in this issue, and Magnus T. Crawford's concrete record of the Snoqualmie Falls operation, as presented at the Los Angeles Institute meeting. They should be of value not only to operators, but particularly to designers who are too prone to neglect these factors. Faultily-designed apparatus handicaps the efficiency of an entire system and can be avoided only by careful study of the conditions under which the plant must run.

Power plant operators have an unwritten law to withhold all information regarding accidents, interruptions and many other occurrences which would be of interest to engineers and of value to the art in general. It is questionable whether such reticence accomplishes its intended purpose, for insinuating rumors usually do more harm than a frank statement of facts upon which to base intelligent action to obviate repetition of like disaster.

As a motto for the operating engineer and as a criterion for the power system, Mr. Wood recommends "capability, reliability, flexibility and repairability," epigrammatic though not etymologic differentials of ability. According to the dictionary, "ability includes every form of power, capability being but the power to receive and efficiency but the power to do." Ability is thus seen to be all inclusive, the integral of the equation of success, and as such we commend it to the designer, who should be able to do as well as plan operating methods.

Irrigation Engineering

Noteworthy among the papers at the Los Angeles session having a bearing on engineering practice in the West was that by O. H. Ensign and James M. Gaylord, describing the application of electricity to the United States irrigation projects in the Salt River basin in Arizona and the Minidoka district in Idaho. In the arid areas of the West the development of every industry except mining has depended largely upon irrigation. The area of the gravity-

irrigated sections, naturally the first to be developed during the past fifty years, is absurdly small in comparison with the total which needs but the magic touch of water to become productive. Recently thousands of acres have been irrigated by gasoline pumping from wells, but this use has necessarily been limited.

Since the commercial use of transmitted electric power, several large hydroelectric companies have systematically encouraged electric pumping by means of a campaign of education as to its advantages to the irrigator. The disadvantages of a low load factor, small units, extensive distributing lines and delayed returns on a large investment are compensated by the ultimate business whose eventual success is as inevitable as is the final peopling of a highly productive but virgin country. But there are many projects of such magnitude as to make their financing impossible for a private company. Several of these have been developed by the government after careful investigation to establish standards of construction and cost. The government is not competing with companies already in the field, but has left the more promising localities to private development. Its influence has been potent in educating the people to see the possibilities of power irrigation and to materially assist further development on a smaller scale in other sections.

Electric Iron Smelting

From time immemorial coal and iron have been as intimately associated as bread and butter, or ham and eggs. The smelting of iron ore requires an intense heat in a reducing atmosphere and some means of supporting and separating the ore particles. Oil fulfills the first of these requirements, but fails in the last. Coal or coke supplies them all in cheap form, whereas charcoal is expensive. As a result, many iron deposits have not been developed simply because coal was not available for their treatment. Recent economies in the generation of electricity, particularly in coalless localities, make it a cheap heating agent for smelting iron, copper and zinc, charcoal or other carbonaceous material performing the combined function of separator and reducer.

For this purpose three types of furnaces have been developed—the arc, the induction and the resistance—with decreasing temperature capabilities in the order named. As the arc furnace has been the most extensively tried in this connection its limitations have been the first found, the most serious being the excessive cost of carbon electrodes and the uneven heat distribution.

These faults and the corresponding advantages of the induction furnace are detailed in C. F. Elwell's paper in this issue with particular reference to steel-making. Though Mr. Elwell has had some little practical experience with the arc furnace and an excellent opportunity to investigate the various European types, his treatment seems somewhat biased in favor of the induction design. Unfortunately, few local engineers possessed sufficient information to meet his arguments at the Los Angeles meeting of the Institute, those so equipped being hampered by commercial restrictions. After much experimenting with the Heroult arc furnace at its plant in Shasta County, California, the Noble Electric Steel Company is now investigating the induction types. Both methods have been successfully developed in Europe, where it has been found that circumstances alter cases, each being best suited for certain conditions.

With power at one-quarter cent, or less, per kilowatt hour, the electric furnace is destined to become a formidable rival of the crucible method of producing high-grade steel, because it is cheaper. Its product is equally good, and far superior to the open-hearth process. In iron-making its greatest field lies in the treatment of low-grade ores whose sulphur and phosphorus cannot be satisfactorily eliminated in the older processes. Thus in time electricity and iron will become as closely coupled in making iron as they now are in generating electricity.

Power Diagram Indicator

Of the more theoretical papers, that in which Professor Harris J. Ryan describes his power diagram indicator stands foremost. This one instrument makes measurements heretofore possible only with complicated switchboard equipment and delicate laboratory apparatus. Its "card" bears much the same relation to the study of conditions in an electric circuit as does that from an engine indicator to those in a steam cylinder.

An X-ray, magnetically focused on a fluorescent screen, is passed through the electrostatic field between four concentric poles, or "quadrants," connected respectively to the voltage and current components of the power in the circuit being studied. The ray is thereby deflected, and in rotating traces a closed diagram whose area is proportional to the energy vertical displacement to the pressure, horizontal movement to the current, and whose inclination shows the power factor. By the use of a revolving mirror the wave-form may also be seen. Furthermore, in the case of a non-conductor the instrument shows the hysteresis loss.

In its present form it is merely a laboratory instrument, which in the words of its creator "has been found satisfactory for the study of high-tension insulation and insulators, dielectric losses in high-tension transformers, insulating qualities of transformer oils as affected by moisture, impurities, etc., losses in the atmosphere from high-tension lines," and similar phenomena. It seems possible of development into the more compact and convenient form necessary for the practical man.

The Conserving Engineer

As a conserver, the engineer has been far more effective than the legislator. The one utilizes natural resources, the other hoards them; one is a humanitarian whose efforts are compounded, the other a miser or a dog in the manger. This is especially true of our unlimited and indestructible water powers which are being bottled up, while other irreplaceable products are being wastefully destroyed for purposes to which hydraulic energy is better adapted.

PERSONALS.

C. L. Cory made a business trip to Los Angeles during the past week.

C. J. York, the head of the Downieville Light & Power Company, arrived at San Francisco last Tuesday.

H. H. Hoxie, manager of the Woodland Electric Works of Woodland, arrived at San Francisco last Tuesday.

Sidney Sprout and A. C. Sprout have returned to San Francisco after a Northern California tour on engineering business.

Melville Lacey, manager of the Hanford Light & Power Company, arrived at San Francisco last Wednesday from Hanford.

Alexander Rosborough, one of the owners of the Siskiyou Light & Power Company's system, was a recent San Francisco visitor.

F. G. Baum, of F. G. Baum & Co., returned last week to his San Francisco office from an important business trip to New York City.

A. W. Smith, secretary of the Sacramento Valley Power Company, with headquarters at Redding, spent last Saturday at San Francisco.

Wynn Meredith, Pacific Coast manager of Sanderson & Porter, left last Wednesday for a three weeks' visit to the firm's New York office.

A. E. Ransom, of the Seattle office of the Westinghouse Electric & Manufacturing Company, has returned to Seattle from a short trip to California.

E. P. Colinan, the electrical engineer of the Tonopah-Belmont Mining Company, arrived at San Francisco from Tonopah during the past week.

Leon M. Hall, of Hall, Demarest & Co., engineers, spent a few days last week at Virginia City, Nev., among his old acquaintances of the Comstock Lode.

W. S. Heger, California manager for the Allis-Chalmers Company, returned to San Francisco during the past week after a visit to his Los Angeles office.

H. C. Stoddard, who is connected with the Rogue River Electric Company of Medford, Ore., left San Francisco last Tuesday and returned to the company's plant.

Darcy A. Lyon, who constructed the original electric furnaces for the Noble Electric Steel Company, at Heroult, Cal., is studying electric iron smelting methods in Europe.

H. C. Goldrick, Pacific Coast manager of the Kellogg Switchboard & Supply Company of Chicago, returned to San Francisco last Saturday after a tour of Oregon and Washington.

Charles C. Moore, of Charles C. Moore & Co., who was recently elected president of the Panama-Pacific International Exposition Company, has returned to San Francisco from New York.

T. F. Jack, head of the detail and supply department of the Seattle office of the Westinghouse Electric & Manufacturing Company, died April 15 from pneumonia complications. Though but 32 years of age, Mr. Jack had already earned a high position and gave promise of a most successful career, thus prematurely ended.

W. P. Hammon, head of the California-Nevada Power Company, the Mojave Power Company and other important hydroelectric corporations, has returned to California after a short trip to New York. The report is current that the business that he was occupied with had to do with the formation of a large oil syndicate in which English and American capital had become interested, with the purpose of securing wells in the Coalinga district.

W. F. Kelly, who has been for the past eight years general manager of the Key Route system and for thirteen years at the head of the Oakland Traction Consolidated, has voluntarily sent in his resignation, effective May 1. His successor has not yet been announced, but it is more than probable that J. Q. Brown, the chief engineer of the entire system, will be appointed to fill the vacancy. He has had years of experience with these lines, and is familiar with all of the details of operation and maintenance.

NATIONAL ELECTRICAL JOBBERS' CONVENTION.

The first Pacific Coast Convention of the National Electrical Supply Jobbers' Association is in session at Del Monte, California, while this issue is on the press, so that a detailed account cannot be given until next week.

The San Francisco delegation, sixty strong, were the first to arrive on the scene, the Eastern and Southern representatives getting in late Monday night after a hilarious and joyful transcontinental trip. Late arrivals are still straggling along but the indications are sure for nearly three hundred, including the ladies.

The meeting, though ostensibly for the purpose of discussing business matters, has developed into a huge junketing expedition, with every facility of California's finest at the disposal of the participants. The jobbers are so greatly outnumbered by the ladies and the manufacturers that business is overshadowed by pleasure.

Tuesday morning's meeting was devoted to roll-call, after which an early adjournment was taken to enjoy the surroundings and recover from the effects of a long train journey. Golf practice occupied the attention of aspirants for tournament honors, while the ladies visited Monterey in automobiles.

Tuesday afternoon the party were the guests of the manufacturers in an automobile trip over the seventeen-mile drive, refreshments being served at the Pebble Beach Lodge. From every sign the convention will be the most successful held in the history of the organization.

PACIFIC COAST A. I. E. E. MEETING.

The second annual Pacific Coast meeting of the American Institute of Electrical Engineers opened with an unexpectedly large attendance on Tuesday, April 25th, at the Hotel Alexandria in Los Angeles, and is in session as we go to press.

On Tuesday morning Mayor Alexander of Los Angeles welcomed the visiting engineers and offered them the city's utmost hospitality. The ladies in the party were taken to Casa Verdugo in automobiles, where luncheon was served. The technical sessions at 10 a. m. and 2 p. m. were devoted to hearing and discussing several papers of which more extended notice will be given in our next issue.

Late in the afternoon adjournment was taken in order that a trolley trip be taken to Redondo, where dinner was served, after the new steam turbine plant of the Pacific Light & Power Company had been inspected.

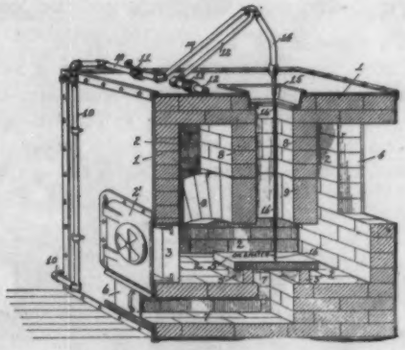
TRADE NOTES.

The Cutler-Hammer Manufacturing Company have moved their Chicago offices from the Monadnock Block to more spacious quarters in the People's Gas Building, 122 South Michigan Boulevard.

The Pelton Water Wheel Company has sold to the Rogue River Electric Power Company a 400 h.p. impulse wheel to be direct connected to the generator, which is to supply current for use in the construction of their new hydroelectric plant on the Rogue River, 30 miles above the present installation.

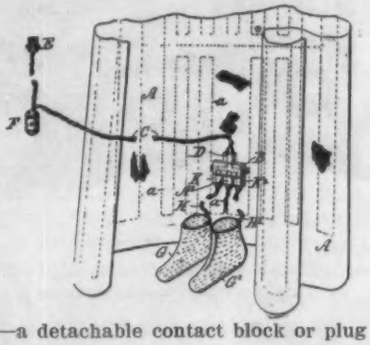
PATENTS

989,828. Liquid-Hydrocarbon Furnace. Julius H. Becker, San Francisco, Cal., assignor of one-half to J. H. King, Oakland, Cal. A liquid-hydrocarbon furnace comprising a shell inclosing a combustion chamber, said shell having in one of its sides a door-controlled opening and in its opposite side a flame exit; a removable firing plate in the lower portion of the chamber, of dimensions adapting it to be inserted and



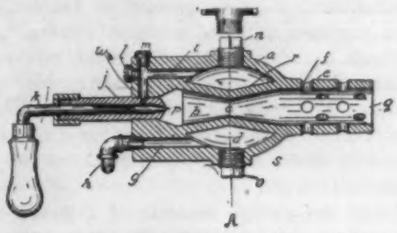
removed through the door-opening; a flue depending from the top of the shell into the combustion chamber and spaced from the walls thereof, said flue opening out above through the top of the shell and opening out below over and spaced from the firing plate; spaced arches springing from the shell walls and supporting the lower end of the flue; and means for delivering the liquid fuel into said flue so that it will fall and spatter upon said plate.

990,206. Foot-Warming Attachment for Electrothermal Garments. Phyllis E. Charles, Portland, Ore. Filed Oct. 12, 1910. The combination with a source of electrical energy, and with a garment wired with a circuit for the diffusion therethrough of electrical currents—of a contact block fixed to the fabric of said garment and receiving the terminals of its



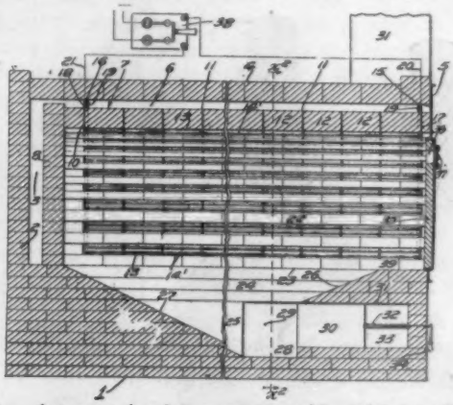
circuit wires,—a detachable contact block or plug and flexible electrical connections therewith,—and separable foot-wraps, or boots, wired also with circuits for the diffusion therethrough of electrical currents, such circuits having their terminals in said detachable block or plug, whereby a common current may be directed through the body and feet of the user.

989,745. Hydrocarbon-Oil Burner. Fred Wissinger and William E. Wilkinson, Portland, Ore. A hydrocarbon burner comprising a casing having a double truncated tube spaced from the walls of said casing, the truncated portions of the tube meeting at approximately the center to provide a choke, the space surrounding the tube forming a generating chamber, the said casing having two extensions connected by a web having an opening, one of said extensions having an opening which communicates with the generating chamber to supply fuel thereto, the other said extension and the web having a duct which communicates with the generating chamber and the opening in the web, a valve casing fitting in the opening in the web and formed with a perforation which registers with the duct, said web and the inner end of the valve casing being spaced from the end of the truncated tube to admit air to the



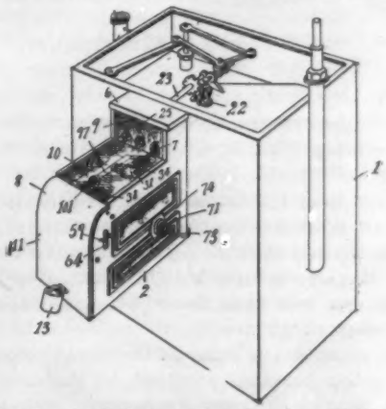
latter, a needle valve operating in the valve casing, and a tubular extension on the casing in line with the double truncated tube, said tubular extension having a series of openings for the admission of air to the vapor.

989,960. Electrical Crematory. Lawson H. Giddings, Pasadena, Cal. An electrical crematory comprising a retort composed of bricks in staggered courses forming open grooves,



electrical resistances in the grooves, said resistance being exposed to the interior of the retort, and hangers of heat-resisting material extending between the bricks and into the grooves to support the resistances.

990,125. Bill-Delivery Mechanism for Meters. Richard W. Gallagher, San Francisco, Cal., assignor to Automatic Billing Company, Los Angeles, Cal. In an apparatus of the character described, the combination, with meter gearing, of a recording wheel, a gear wheel for intermittently advancing said



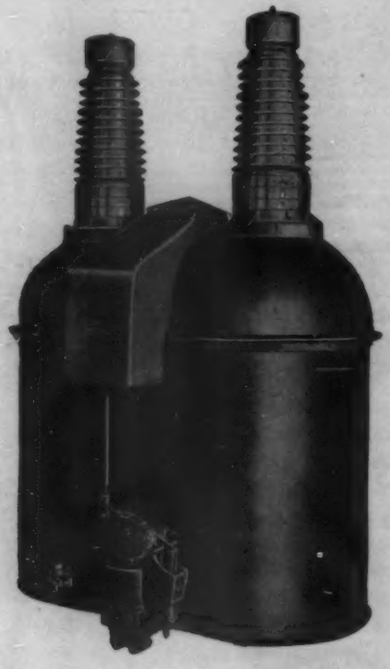
recording wheel, means for moving the recording wheel bodily to take a record therefrom, an operative connection between said gear wheel and gearing, inoperative when the wheel has been so moved and means adapted to be brought into operative connection with said gear wheel when the latter is out of operative connection with the gearing to turn said wheels to zero.

INDUSTRIAL

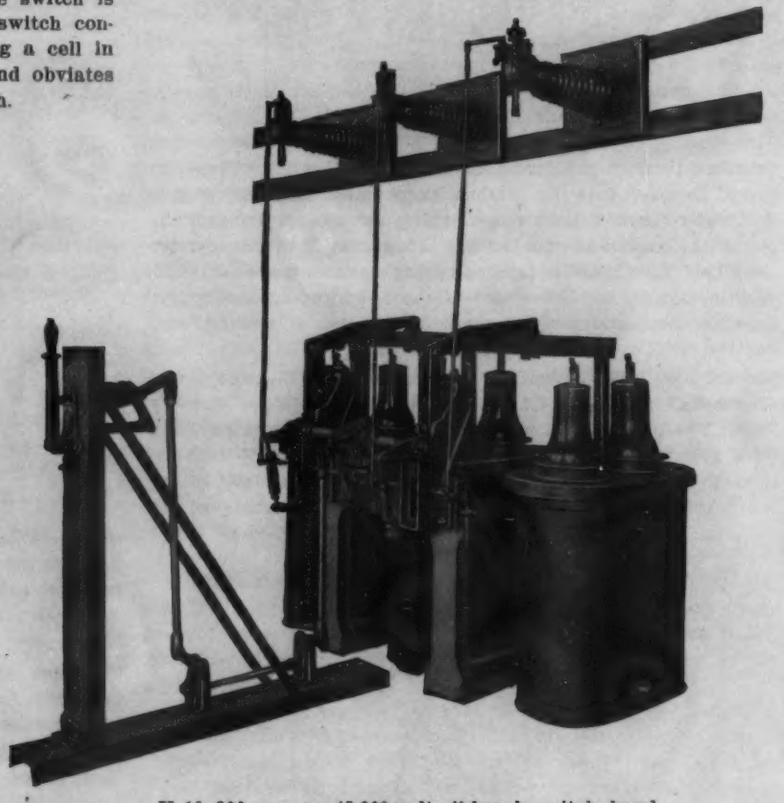
NEW OIL BREAK SWITCHES.

The modern tendency in the electrical field has been towards the use of apparatus of larger and larger capacities. This has necessitated the development of devices capable of opening large currents at high voltages without introducing disturbing effects on the system. Since the oil break switch is the only known commercial device which will accomplish this, a discussion of a new form which the General Electric Company has recently developed to meet requirements in modern large capacity stations employing voltages from 22,000 to 110,000, will be of interest.

The body of the switch consists of a heavy boiler iron tank. This contains the oil and also supports the switch leads and operating parts. The tank rests directly on the floor and no cells or barriers are required. The switch is built in single-pole elements; i. e., a three-pole switch consists of three elements, each element constituting a cell in itself. This reduces the floor space necessary and obviates the cost of constructing cells to contain the switch.



Single element of Form K-15, 100 amp., 110,000 v. oil break switch, solenoid-operated



K-10, 300 ampere, 45,000 volt oil break switch, hand-operated with series relay mechanical trip.

In general the construction of these switches is similar to that of the other Form K oil break switches made by the General Electric Company, in that they have a vertical motion of the contact rods and a double break for each circuit. When the switches are opened the contact blades move rapidly downward, opening the circuit in oil. The switches have ample air space above the oil and are suitably vented to prevent oil from being thrown out when the switches are opened on extreme overload or short circuit.

With the exception of some of the lower voltages, where one-piece porcelain bushings are used, all bushings are of the built-up type, similar to those which have been successfully used for some time on the General Electric 45,000-volt oil break switch and on high voltage transformers. The built-up bushings have porcelain ends, intermediate rings of compound with treated fibre washers between the latter. The washers are of large diameter and increase the creepage surface. The bushings after assembly are filled with special insulating compound of high dielectric strength.

The design of the contacts is such that on rupturing the circuit the arc always takes place on the upper extremity of the moving contact and on the flared portion of the stationary one, so that the actual current carrying contact surfaces are always protected. At rated loads the switches have a low temperature rise, in no case exceeding 28 degrees Centigrade.

The switches can be operated by hand, by a solenoid mechanism requiring a direct current source of power, or by a diaphragm mechanism using compressed air, and are arranged for either non-automatic or automatic operation on overload. The weight of the moving parts is counterbalanced by adjustable tension springs, so that the switches close easily and open without excessive jar. The different kinds of operating mechanisms are as follows:

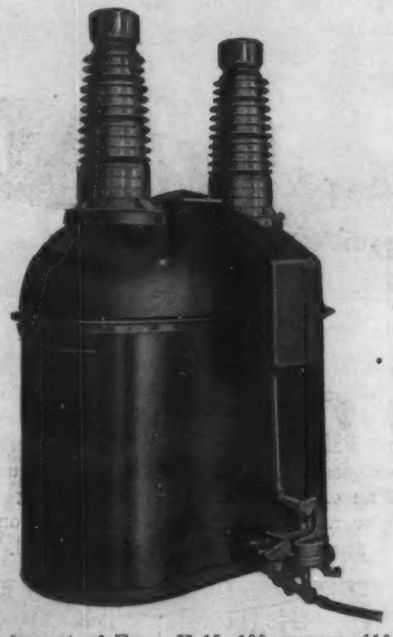
The hand mechanism consists of a handle or operating lever mounted on a panel or other suitable support. In closing the switch the lever moves through an arc of 180 degrees. It has a very powerful toggle which exerts the maximum power at the end of the stroke and makes it possible to close the switch contacts under heavy spring pressure. On all non-automatic mechanisms, provision is made for adding overload protection at any time without difficulty. The mechanism for overload operation has a trip free from the handle feature so that the switch cannot be held closed on overload or short circuit.

For solenoid operation the operating handle, bell cranks and pipe connections are replaced by one or more solenoid mechanisms, each of the latter being provided with a large coil to close the switch and a small coil to trip it. A control

relay is used to close and to open the closing coil circuit, the control switch thus having to handle the small current of the control relay coil only. The trip coil of the solenoid operated switch is energized by a hand operated control switch or by an overload circuit closing relay when used. Solenoids are made for use on 125, 250 and 650 volts direct current.

For remote control, where a convenient source of direct current for operating the switch is not available, air operated mechanism can be used.

To provide for the automatic protection of apparatus, under abnormal conditions of overload or short circuit, two methods, by series relays (series relay trip) or by current transformers (current transformer trip), are commonly employed. A selection between them and the various combinations under each depend upon the conditions of operation in the particular case as well as upon the cost of installation.



Single element of Form K-15, 100 ampere, 110,000 v., oil break switch, pneumatically-operated.

Series relays are similar to standard switchboard relays with or without bellows attachment for instantaneous or time limit operation respectively. They are all single-pole, and each is mounted on a post insulator. The post insulator is clamped to a base which may be mounted on the side wall of the station or to a support directly above the switch. The relays are connected in series with the line, one or more being used according to the system employed.

Series overload relays with mechanical trip with or without the inverse time limit feature are used with hand operated switches where a convenient source of direct current for tripping is not available. The relay mechanism acts directly through a treated wooden rod and tripping shaft upon a small auxiliary toggle which releases the main switch toggle and opens the oil switch.

The series overload relay with electrical trip is similar to the ones just described except that the wooden connecting rod actuates a small switch and closes an electrical circuit through a trip coil which in turn opens the oil switch. This method of tripping is used with solenoid operated switches. It may also be used with the air operated switches, being connected in a manner similar to that just described, except that low tension alternating current is used to actuate an electrically operated air control valve.

High voltage current transformers when accurate and reliable, are more expensive than series relays, and are therefore seldom used for tripping switches except when it is necessary to use the current transformers with wattmeters, watthour meters, or reverse current relays. In general, the operation of these switches by means of current transformers is the same as with lower voltage apparatus using standard switchboard relays, and varies only in the combinations for the different operating mechanism.

When current transformer trip is used with hand operating mechanism for "K-10" and "K-15" switches, it is necessary to have a trip coil on the oil switch mechanism. Provision for this is made so that it may be added at any time without difficulty. With direct current trip, a single direct current coil is used. With alternating current, a similar coil or coils are used.

When current transformer trip is used with solenoid operated mechanism, direct current is available and circuit closing relays are used connected in parallel with the opening side of the control switch and the tripping coil of the solenoid mechanism.

When current transformer trip is used with air operated mechanism, it is customary to have the trip coil on the switch mechanism. Circuit opening relays are used with a single trip coil in the secondary of the current transformers and entirely separate from the alternating current control circuit for the electrically operated control valve.

Automatic operation on reversal of current is obtained by the use of reverse current relays in the secondary of current transformers and combinations are similar to those described under current transformer trip.

The "K-10" switch is used on systems with voltages of from 22,000 to 110,000 volts on which the combined normal energy delivered to the bus is not greater than 20,000 kilowatts. The "K-15" oil switch is used on systems with voltages of from 70,000 to 110,000 volts on which the combined normal energy delivered to the bus is not greater than 50,000 kilowatts.

TRANSMITTERS AND RECEIVERS IN THE MAKING.

The average telephone user gives very little thought to the why and wherefore of the transmitter and receiver. He thinks of the telephone as a national and personal convenience, but seldom has any conception of what the instrument really is. To get the wide range of notes from a stringed musical instrument a large number of vibrating strings are necessary. How much more wonderful then are the little telephone transmitter and receiver with their single vibrating diaphragm. These instruments receive and transmit the human voice over miles of wire under a multitude of conditions. Not only will they transmit and receive the comparatively few notes of a piano, but they will reproduce the individual characteristics of the human voice over great distances.

The manufacture, inspection and testing of these instruments forms an interesting story, and the accompanying illustrations show some of the processes involved.

Some idea of the magnitude of this branch of the telephone making industry may be had from the statement that over one million pair of transmitters and receivers were manufactured during 1910 by the Western Electric Company alone. In producing this great number of instruments fifteen hundred tons of brass, three hundred tons of steel and at least two hundred tons of rubber and other raw materials, including thirty-five million screws, were consumed. All of this apparatus was made in the big factory fronting on West Street, New York City, which ranks second only to the immense Hawthorne works of the same company.

The Transmitter.

The transmitter is one of the most delicate pieces of apparatus on the commercial market. Several of its parts must be held to such close dimensions that the Western Electric Company was confronted with the problem of making

not only the telephone instruments but much of the necessary testing apparatus and measuring instruments. Such instruments as those used to measure the thickness of the mica, which is held to within three ten-thousandths of an inch, were made in the company's own shops. It is interesting to note that in order to secure mica that can be cleaved to such small dimensions it is found necessary to import it from India and that because of the difficulty met with in separating even this selected mica into exactly the right dimensions fully 80 per cent is rejected.

Testing the Transmitters.

Another important operation is the manufacture of the carbon granules contained in the transmitter button. These granules must have exactly the right degree of hardness, otherwise the tone of the transmitter will be affected. They must be of uniform size, otherwise the transmitter would have a tendency to pack, and, in addition, just the right amount of carbon granules must be used. The carbon is measured in a cup having a steel cut-off, which insures the correct volume. In order to see that the carbon is running with the right ratio of weight to volume a certain percentage of the buttons are weighed by means of a delicate balance and a close check is kept on them.

The front and back electrodes are also made of carbon. Each is as highly polished as a steel mirror and each one must have just the proper degree of hardness, otherwise pitting would result from the passing currents, which would affect the transmission and might result in packing.

Testing.

It testing most telephone apparatus, such as generators, drops, relays, etc., it is possible to measure their efficiency in concrete terms and with practically no human factor entering into the results of the tests. Since the primary function of a transmitter is to transmit the human voice, it becomes necessary in testing their efficiency to make use of the human voice, and thus the human element enters. The volume and articulation test is made over a circuit line which is the equivalent of an actual line two hundred miles in length. The operator standing at the receiving end signals back to the man testing the transmitter, telling him whether the volume and the articulation is satisfactory. In order to eliminate carelessness as far as possible from this test the inspectors do the talking and receiving in pairs. In the morning one does the talking while the other is receiving, and in the afternoon the operation is reversed. By long training at this work these men are able to pick out a variation in efficiency to a fraction of one per cent. Any transmitter that does not measure to the standard transmitter must go back for readjustment.

Besides the transmission test, the transmitters must also survive what is known as the mechanical inspection, which includes a minute, detailed inspection of every one of the piece parts going to make up a section of the instrument, each group of parts as assembled, and finally the completed instrument.

The Receiver.

The receiver is another delicate piece of electrical apparatus and successfully to manufacture it requires special machinery and skilled labor. The steel from which the magnets are made must be carefully chosen and then comes the proper tempering and magnetizing of it. Formerly skilled men

Final Inspection of Transmitters.

were employed to determine when the steel was heated to just the proper temperature for emersion, but after years of experiment a way was devised and placed into effect by which "human error" was eliminated. Today the temperature of the annealing furnaces is kept at a pre-determined uniform heat by means of an electrical indicator. By placing the steel in the furnace for a prescribed time the exact conditions for producing the fine degree of temper are obtained.

Final Inspection of Receivers.

Another important member of a receiver is the vibrating diaphragm, whose thickness must be held to within two thousandths of an inch. The space between the ends of the pole pieces and the diaphragm must be held to a dimension as close as .015 in., for any greater dimension would decrease the efficiency of the receiver, and any less dimension would make the instrument so delicate that hard usage would put it out of commission.

The receivers are given the same rigid talking and mechanical tests as those given to the transmitters mentioned

above. Maximum efficiency over the longest possible period of service both in the transmitter and receiver is the result of the pains taken by the company in the manufacture of this apparatus.

THE LARGEST REINFORCED CONCRETE FACTORY IN PHILADELPHIA.

It has just been announced that The Electric Storage Battery Company at 19th Street and Allegheny Avenue has closed a contract for the design and construction of a new reinforced concrete building which will be the largest manufacturing building of this type in the city. This addition to its present plant will be a building approximately 300 ft. long by 115 ft. wide, six stories high, with a one story triangular extension about 80 ft. by 120 ft. These buildings will be constructed by the patented system of mushroom reinforced concrete construction and will be designed to meet the particular demands of this company.

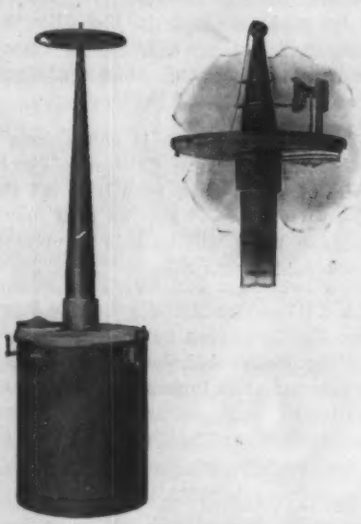
The demand for storage batteries of this company's manufacture has increased to such an extent that it has been necessary to provide additional manufacturing facilities at once.

The Electric Storage Battery Company has recently closed contracts with many of the large electric lighting companies for enormous "Exide" storage batteries for emergency service, and these large orders together with the enormous demand recently made upon the company for the "Exide" and the new "Ironclad-Exide" electric vehicle batteries have greatly increased the business of the company.

These new buildings will be of the most up to date design, strictly fire-proof, will be provided with the most modern machinery and the best facilities for the convenience of its employees. The construction of these buildings is to start at once to be completed during the Fall and will give employment to a large additional force of workmen.

HIGH TENSION ELECTROSTATIC VOLTMETER.

For the measurement of high potentials, of 25,000 volts or more, the common practice is to use voltmeters operating on the electrostatic principle. The current required to operate an electromagnetic voltmeter would at high pressures require a kilowatt or more of energy, while a voltage transformer to



reduce the voltage on the meter to a safe value would be excessively large to secure the proper insulation. An electrostatic voltmeter, on the other hand, consumes practically no power, and its construction can be made more simple than that of a voltage transformer for high voltage.

The latest type of electrostatic voltmeter, recently brought out by the Westinghouse Electric & Mfg. Company, Pittsburg, Pa., contains several unique features not found in any previous types. These features tend to make the instrument entirely free from the influence of exterior static fields and provide ample insulation for voltages as high as 200,000 or more without adding greatly to the size of the device.

The mechanism consists of a condenser type of terminal and a measuring condenser element mounted in a sheet iron tank with cast iron cover. The current carrying parts are immersed in oil, which allows the instrument to be compact by increasing the dielectric strength between the measuring surfaces, and also acts as a damper and produces dead beat readings.

The terminal consists of concentric alternate insulating and conducting layers, which form in effect a large number of condenser in series. The moving element, which is in parallel with several condensers at the grounded end of the series, consists of two closed cylinders carried on opposite ends of a cross beam hung by a glass shaft from a special ball bearing. The cylinders move between two curved plates one attached to the tank and the other to an outer layer of the terminal.

When the core of the condenser type terminal is connected to one side of the high tension circuit, and the tank is connected to the other side, grounded, the total difference of potential is divided up among the various condensers in series, and charges of opposite polarity, proportional to the voltage, are induced on adjacent faces. Each cylinder of the moving element is charged oppositely to the curved plate nearest to it, and an attraction exists between the charges on the cylinders and on the plates, which tends to cause rotation of the moving element. This rotation is opposed by a spiral spring so that the deflection is a function of the charge and consequently of the voltage. The deflection is indicated by a pointer carried by the shaft and read on a horizontal scale. The scale is provided with a mirror to prevent parallax, and reads both in volts and in proportional divisions.

By short circuiting layers of the condenser terminal, a higher difference of potential exists across the remaining condensers, and the deflection is correspondingly increased for low voltage. Provision is made for reading full scale at one-half and one-quarter voltage; the necessary connections being made without opening the case.

The use of the Westinghouse condenser type terminal makes a very compact instrument. A 200,000 volt meter, for instance, is 3 ft. in diameter and 3 ft. high, and the terminal projects 63 inches above the cover of the case.

NEW CATALOGUES.

In Bulletin No. 4816, recently issued by the General Electric Company, is described a new running light telltale board placed upon the market by this company, which affords a reliable means of indicating whether or not the running lanterns of an electrically lighted vessel are lighted.

The General Electric Company has just issued Bulletin B 3038, entitled "Electricity on the Farm." The bulletin is divided into brief chapters, each covering a specific use for electricity on the farm, the various descriptions of motor applications being accompanied by illustrations of electrically operated farm machinery in actual service. The section covering barn and field machinery includes description and illustrations of motor operated hay hoist, ensilage cutter, thresher, grist mill machinery, etc., while the chapter on electric drive for dairy apparatus shows the use of motor driven vacuum pumps for the operation of vacuum milking and cattle cleaning outfits, motor driven separators and churns. Other chapters deal with electrically operated refrigerating plants to meet the requirements of the average farm, the application of motor drive and auxiliary electrical devices in the farm workshop, and the possibilities of electric haulage for farm products.

NEWS NOTES

INCORPORATIONS.

SAN FRANCISCO, CAL.—The Sacramento-Sierra Power & Water Company has been incorporated by C. C. Chapman, C. L. Barsotti, John Muldoon, Dudley Smith and C. J. Lancaster, with a capital stock of $2,500,000.

FINANCIAL.

SANTA BARBARA, CAL.—The Santa Barbara Gas & Electric Company has decided to ask the stockholders to ratify a proposition to put out a bond issue of $1,000,000, the measure being voted at the directors' meeting held in this city last week. The new bonds will bear 6 per cent interest, and the plan is to substitute them for the 5 per cent issue of the same amount which it has been found difficult to float. The bonded indebtedness of the company will not be increased by the recent action, but a more attractive bond to investors will be offered. At the present time $680,000 of the 5 per cents are held as security for loans, there being no direct sale for them. All these 5 per cent bonds will be called in as soon as the new issue is on the market.

ILLUMINATION.

BAKER CITY, ORE.—The bond issue of $25,000 for the construction of an electric power plant has been passed.

PORTOLA, CAL.—The Portola Lumber Company is to provide the first electric lights and power to Portola.

SEATTLE, WASH.—Bids have been rejected and will be readvertised for an electric chassis for the lighting department.

SANTA ROSA, CAL.—The Sebastopol Light & Power Company has petitioned the Superior Court for permission to dissolve its corporate existence.

VICTORIA, B. C.—Hutchinson Bros. have secured the contract for the installation of the electrical system for the cluster lights on Fort street, to cost $1400.

SALEM, ORE.—The Board of Trade will hold a meeting for the purpose of deciding the question of installing cluster lights on the streets.

ROSEBURG, ORE.—The City Council has granted to W. F. Boardman & Co., of San Francisco, a 50-year franchise on the streets and alleys of Roseburg for gas purposes.

EUGENE, ORE.—Alvin Myers, engineer, Eugene, Oregon, has just completed construction of a municipal electric light plant for his city at Waterville, costing approximately $200,000.

LOS ANGELES, CAL.—The Board of Supervisors has denied the application of the Southern California Gas Company for a blanket franchise covering Los Angeles County.

WALLA WALLA, WASH.—The Pacific Power & Light Company announces that work will be started immediately on the construction of a transmission line from this place to Dayton, to cost about $50,000.

PASCO, WASH.—Plans have been completed by the Pacific Power & Light Company for the construction of a new power and switching station; work will commence about June 1.

RICHMOND, CAL.—The Oakland Gas Company, which supplies Richmond, has reduced its rate from $1.50 to $1.25 per 1000. The company will at once take steps for the betterment of its service and the extension of the mains to all parts of the city.

LEWISTON, IDAHO.—The Lewiston-Clarkston Improvement Company plans to inaugurate a development of electric power in the Lewiston-Clarkston project, which will result in the early construction of an electric railway.

MONTESANO, WASH.—An election will be held here this month to decide the question of purchasing the plant of the Montesano Water & Light Company. The proposed issue will call for $125,000.

PASCO, WASH.—An election will be held to decide on a $50,000 bond issue, $30,000 to be used for the purchase of the city water plant from the Pacific Power & Light Company, and $20,000 for other improvements.

NORTH YAKIMA, WASH.—City Engineer Doolittle has presented an estimate of $250,000 for the construction of the proposed new municipal light and power plant. The complete plants for the proposed system will be completed by June 1.

CLAREMONT, CAL.—The City Council has passed an ordinance granting to the Pacific Light & Power Company a franchise for a period of 50 years to erect poles, etc., along Mills avenue from N. First to the north city limits.

SEATTLE, WASH.—The offer of P. H. Hebb of Tacoma to sell his White River property as a power site to the city of Seattle has been turned down. The purchase price is considered too high.

HAWTHORNE, CAL.—At an election held here to vote on the question of establishing a lighting district to give Hawthorne street lights, the proposition carried by a large majority. The Supervisors will advertise for bids.

TACOMA, WASH.—The Tacoma Gas Light & Power Company, owners of patents for producing illuminating gas from garbage, has applied to the municipal commissioners for franchises that will enable it to put in a system equal in capacity to the city's present coke gas supply system.

MONROE, WASH.—The Everett Gas Company has decided to extend its gas mains to Monroe. Application for a franchise will be made at once to the City Council. The lighting company will put up a two-story cement or brick building for office purposes and as a transformer station, making an investment of about $30,000.

WILLOWS, CAL.—Fast work is being done on the Willows gas plant of the Northern California Power Company. More than a mile of mains have been laid and the remaining four miles will be put down within the next four weeks. Gas is promised by June 1. It will be sold to private consumers at $1.50 the 1000 cubic feet.

WALLOWA, ORE.—The McCully-Rumble Power Company plans to develop 1000 h. p. on a newly acquired power site on the Wallowa River 20 miles below this place. Among the plans of the new company is to purchase all franchises in this and Union counties to supply electricity for power to all rural districts in this vicinity and to furnish light and power between Joseph and La Grande.

BAKERSFIELD, CAL.—A. E. Wishon, assistant general manager of the San Joaquin Light & Power Company, announces a reduction of 25 per cent in all electricity charges effective in July. Mr. Wishon says: "July 1 we will have power from our new generating plant at Crane Valley, into Bakersfield, and this will enable us to furnish electricity to all consumers cheaper than we are doing now, and accordingly our charges for the same will be reduced. The reduction is general and all users of electricity will benefit by it."

NEWPORT, WASH.—Arrangements have been completed for the establishment of a line from the Newport sub-station of the Northern Idaho & Montana Power Company to Priest river, and the necessary equipment for same has been ordered. The proposed line will carry 11,500 volts and will furnish Priest River with lights.

TACOMA, WASH.—George Milton Savage of Nisqually Construction Company, Savage-Scofield building, announces that warrants in the sum of $1,074,938.74 issued against the light and water fund to pay Hans Pedersen, a Seattle contractor, for constructing the second unit of the municipal hydroelectric plant at Nisqually River, have been successfully disposed of to Eastern investors.

NORTH YAKIMA, WASH.—H. J. Doolittle, city engineer of North Yakima, has made a thorough study of the preliminary plans for the proposed municipal light and power plant, and states that he will be able to furnish light and power to the consumers at a much lower rate than that charged by the company now furnishing light to the city. Mr. Doolittle will present complete plans to the council on June 5 for the plant which will cost $250,000.

SACRAMENTO, CAL.—Governor Johnson has signed an Assembly bill compelling gas companies, electrical companies and other concerns engaged in the business of furnishing heat or such things to sell those commodities to persons desiring them. The measure provides that in case of refusal the applicant, after ten days, shall be entitled to collect $50 from the company and the sum of $5 per day for each day thereafter that the gas, electricity or heat is denied.

MARYSVILLE, CAL.—Paul Downing, the engineer of electrical construction of the Pacific Gas & Electric Company, states that the present flume and ditch system carrying water for eight miles around the sides of a mountain to reach the Colgate plant east of here is to be abandoned. Instead a big tunnel will be pushed through the mountain. Another improvement to be made is the substitution of steel towers for the present poles on the main transmission lines from Colgate to San Francisco Bay.

LOS ANGELES, CAL.—The Los Angeles Gas & Electric Company was assessed illegally when the County Assessor taxed it doubly in 1908 for a city street franchise as a penalty for its not paying that tax in 1907, according to a decision rendered by Judge Wilbur in the suit against the county. The court held that the franchise under the State law which was taxed included the rights of the corporation to use the city streets, and the County Assessor had no right to assess the corporation for its street franchise. The corporation was assessed in 1907 for both the State and city franchise, but later had the latter assessment canceled. In 1908 the Assessor taxed them doubly, claiming that the tax the year before had been evaded. The corporation paid under protest and then proceeded to bring suit.

LOS ANGELES, CAL.—The first step in the city's plan to organize a power and light bureau for the purpose of developing the electrical energy along the line of the aqueduct and constructing the plants for generating and distributing the light and power derived therefrom has been taken by Mayor Alexander. He has sent to the public service commission, a communication urging the immediate organization of the bureau and the development of the resources that belong to the city. Mayor Alexander points out four separate propositions which the commission might undertake, embodying four distinct places along the aqueduct where power may be developed. These are San Francisquito No. 2, San Francisquito No. 1, San Fernando and Haiwee. The amount of electrical energy that could be derived at these four places is, respectively, as follows: 32,000, 60,000, 9000 and 10,000 h.p. The respective cost would be as follows: $2,300,000, $3,300,000, $750,000 and $1,500,000.

TRANSMISSION.

GREENVILLE, CAL.—President O. C. Pratt of the Indian Valley Power Company, with Mr. Lang of Stockton, have inspected the local electric light plant and are considering plans for the extension and enlargement of the present installation.

RENO, NEV.—The Truckee River General Electric Company is seeking a right of way for a high-tension power line from its new plant near Verdi to Virginia City and has commenced a condemnation suit in the District Court to secure the possession of the same. The suit has been filed against Botholomeo Chilleri.

JACKSON, CAL.—Announcement is made here that the Sierra Blue Lakes Power Company has decided on a location for its dam to be constructed to form a reservoir in the valley below the mouth of Blue Creek. The dam, it is stated, will be erected at a point a mile and a half below the mouth of Blue Creek. It is proposed to make it 800 feet high. The reservoir will be the entire valley at the mouth of Blue Creek.

OROVILLE, CAL.—Leo Van der Naillen will resign as manager of the Oro Water, Light & Power Company to accept the position of general manager of a power company with a capitalization of $10,000,000, which will be incorporated by the principal stockholders of the local company. The new company will carry power to San Francisco and Sacramento. The new company of which Van der Naillen will be general manager will be incorporated for the purpose of developing the power proposition in Plumas County now owned by stockholders of the Oro Water, Light & Power Company, among whom are J. W. Goodwin, Luther Holton and James K. Moffitt, well-known financiers of San Francisco.

TRANSPORTATION.

HANFORD, CAL.—The Hanford & Summit Lake Railway Company will soon begin construction work on extending its line to Jamison, Cal.

FRESNO, CAL.—About half the Sunnyside car line has been reconstructed by the Fresno Traction Company, which began the work ten days ago.

CHICO, CAL.—The Northern Electric Company has applied to the City Board of Trustees for a franchise to put down double tracks on Main street.

CENTRALIA, WASH.—An ordinance has been introduced in the Chehalis Council providing for a franchise for the new Chehalis & Cowlitz Railway, to run 50 years.

FRESNO, CAL.—The Supervisors have passed an ordinance granting to the Summit Lake Interurban Railway Company a franchise in the county of Fresno.

SEATTLE, WASH.—L. G. Gray, a Seattle shipping man, and associates are seeking rights of way for an electric railway line through Bremerton, Charleston, Port Orchard, Union City, Sheltan and Clifton to Grays Harbor.

LOS ANGELES, CAL.—J. B. Rowray has resigned as superintendent of the northern division of the Pacific Electric Railway Company to become superintendent of the Northern Electric Railway, with headquarters at Chico. The change will become effective May 1.

ALAMEDA, CAL.—Industrial Agent F. W. Hoover of the Southern Pacific Company announced yesterday that the Alameda electric service on the south side line would start promptly on June 1, as announced some time ago by the Southern Pacific head officials. The north side of the loop will not be given an electric train service until the Oakland side of the present steam horse-shoe route is made over into a part of the electric system.

HELENA, MONT.—It has been announced by J. H. White, manager of the Helena Light & Railway Company, that bonds in the sum of $100,000 for the purpose of double tracking the line from this city to the fair ground will be placed on the market.

SEBASTOPOL, CAL.—Hon. John D. Connolly has started a petition to the magnates of the Northwestern Pacific Railway Company to have the third rail extended from Monte Rio up to Camp Meeker and Occidental and a standard gauge train service operated thereon.

SAN RAFAEL, CAL.—Work will soon be commenced on the building of the electric road from Petaluma to a landing on the bay near Marin Islands east of San Rafael. The road is to come by way of Novato and will reach the bay through the valley just beyond the Towne ranch—this side of McNear's point.

WENATCHEE, WASH.—L. W. Pratt, president National Realty Company, Bankers Trust Building, Tacoma, has asked for franchises for a street car system here and for a line to Leavenworth and Cashmere. He will bring Sound capitalists representing $20,000,000 to Wenatchee the coming week to look over the project he is endeavoring to promote.

GLENDALE, CAL.—The Pacific Electric Railway Company has asked for a franchise for one track between Glendale and Burbank. The right of way will be wide enough for two tracks, however, and will be graded for a double immediately, but only only track will be rushed to completion. The cost is estimated at $222,000, and the line should be finished in three months.

PATEROS, WASH.—O. A. Hoag, real estate man, has applied to the commissioners of Chelan county for a fifty-year franchise giving him and his associates the right to occupy a portion of the road between Chelan and Wenatchee and between Chelan and the boundary line of Okanogan county with an electric transmission line for lights and power and with an electric railroad.

VALLEJO, CAL.—Crews of the Vallejo & Northern Railway Company have been placed at work between this city and Suisun and the new line to be built between Vallejo and Sacramento will be ready for use when the new bridge across the Sacramento River at Sacramento is completed. The railroad is being constructed of the heaviest type of rails. Work on the bridge is expected to be finished by August.

SAN FRANCISCO, CAL.—Electrification of the lines between San Francisco and San Jose is planned by the Southern Pacific. This is a part of the announced plan to establish a four-track line between this city and Redwood City with a possibility that the four tracks will be extended as far as San Jose. However, plans for the immediate future have in contemplation only the extra tracking and the electrification of the line between here and points on the peninsula where the passenger traffic has increased so rapidly.

SAN JOSE, CAL.—The first big construction plan for local electric railroads under Southern Pacific ownership will be a loop line of 15 miles connecting Alum Rock Park, Berryessa and this city. This is announced by F. E. Chapin, general manager of the local lines. The line will be double tracked and standard gauged, and will, it is certain, go into the park via the present narrow gauge route to the mouth of the canyon. From Alum Rock back to the city it will go further northward, tapping the Berryessa orchard region, and will be in a position to be a direct competitor in local service over five or ten miles of the route, which the United Properties must take to enter this city from the Oakland side of the bay. The cost of the proposed new route is estimated at between $500,000 and $600,000.

TELEPHONE AND TELEGRAPH.

MOUNT VERNON, WASH.—The City Council is planning to order all telephone, power and light wires underground in the business district.

PORT HILL, IDAHO.—Representatives of the Bell Telephone Company are working in this vicinity to secure subscriptions to warrant the extension of a telephone line to Port Hill from Bonners Ferry, to cost $1500.

SANDPOINT, IDAHO.—J. E. Barton, superintendent of the Pend Oreille forest reserve, has received word from the forestry department that the Pend Oreille forest will be allotted $5500 this year for improvements. A telephone service will be established and a trail road built.

TACOMA, WASH.—The Home Telephone Company of Puget Sound, W. D. Tyler, receiver, Home Telephone Building, will install local systems and connecting lines on roads between same in Fleet, Custer, Clinton, Lake Steilacoom Park, Interlaken, Lakewood, Lake Grove, American Lake and American Lake additions to Lake City, at an estimated cost of $60,000.

WATERWORKS.

BELLINGHAM, WASH.—A petition has been presented for the extension of water mains and the placing of fire hydrants on Electric avenue; cost about $4000.

BAKER CITY, ORE.—At an election here the following bond issues were passed by the voters: The sum of $90,000 for water system repairs, $25,000 for a new reservoir and $45,000 for paying intersections.

ELGIN, ORE.—The water commissioner of the city has employed J. R. Thompson, 301 Couch building, Portland, to superintend the improvement of the water system of this place; cost to be about $10,000.

BELLINGHAM, WASH.—The petition presented by the people on Electric avenue for the expenditure of about $3700 for the installation of water mains has been accepted by the water board and costruction will start soon.

SANTA MONICA, CAL.—R. H. Dow, F. D. Butzer, C. A. Stils and others have taken desert claims in Inyo county and are organizing the Rose Spring Valley Water Company to develop artesian wells on its holdings.

OLYMPIA, WASH.—The new Northern Hospital for the Insane at Sedro-Woolley will have a water system costing about $20,000, with a double reservoir plant, having a storage capacity in excess of 700,000 gallons. The State Board of Control announced that Josiah H. Moore, of Seattle, has just completed the plans for this plant, the contracts on which will be awarded within a short time.

SAUSALITO, CAL.—Congressman William Kent is making preparations to install a water system at Willow Camp. His private secretary, J. E. Webb, has filed on the waters in steep canyon, and in a short time a contract will be let for building a concrete reservoir in the ravine. A pipe line several miles in length, will be run from the reservoir to the new hotel site, and a distributing plant will be installed through the district.

BERKELEY, CAL.—Action has been deferred on the water rate question until May 9 in order that the City Council may determine the value of the property owned by the water corporation, with a view to learning if returns on the investment at the present rates will not warrant a reduction. Manager C. L. Maloney of the People's Water Company, has presented a report to the Council showing gross profits to the company of $98,537.89 for last year's business on a total valuation of the system of $2,574,087.48 equal to 3 92/100 per cent profit on the investment. The receipts for the year were $255,115 and the expenditures $156,577.11.